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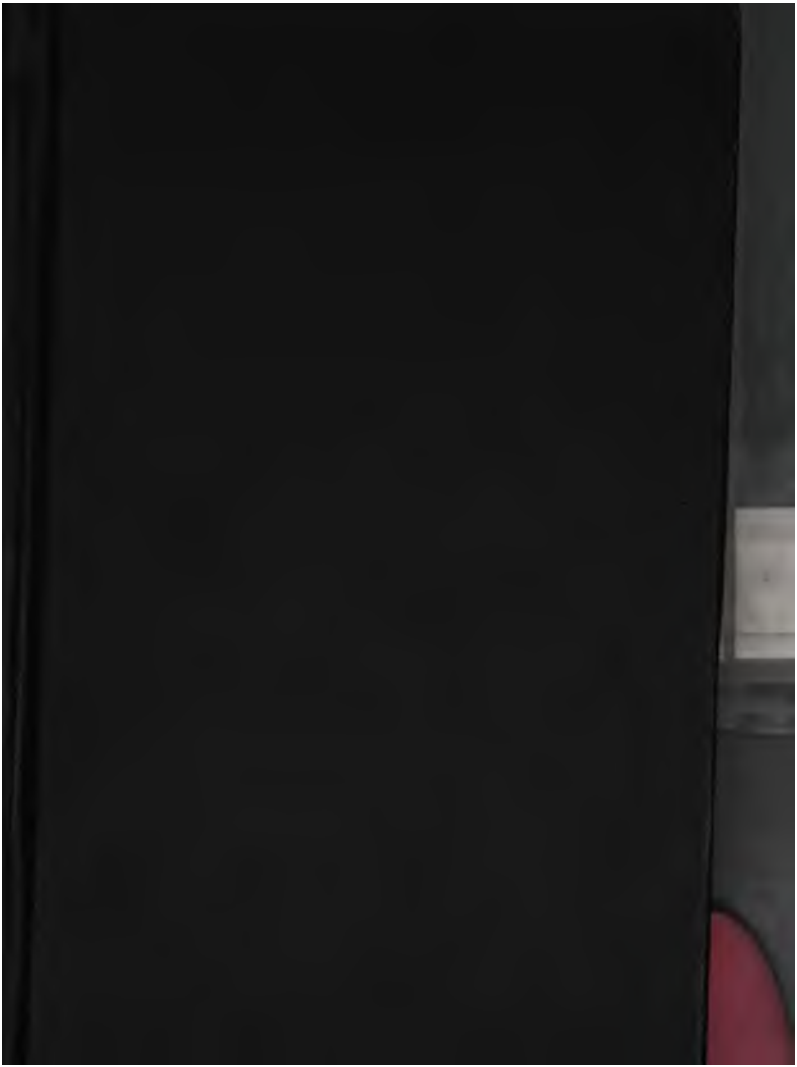

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THE

CHRISTIAN PHILOSOPHER;

DESIGNED TO EXHIBIT

IN THE

OUTLINES OF NATURAL HISTORY,

AND THE

ELEMENTS OF PHYSICS,

THE

WISDOM, BENEFICENCE,

AND

SUPERINTENDING PROVIDENCE OF THE DEITY,

IN THE

WORKS OF CREATION

BY WILLIAM MARTIN.

WITH ORIGINAL POETICAL ILLUSTRATIONS.

"Te in scientiâ profecisse credas quantum in moribus fueris emendatior; eo usque doctum, in quantum bonum: ita philosophum, ut Christianum."—*Pref. ad Nem.*

LONDON:

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1832.

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TO

WILLIAM ALLEN, Esq.

THE FRIEND OF THE

ARTS AND SCIENCES

AND

PATRON OF

RELIGIOUS EDUCATION

AMONG ALL RANKS OF SOCIETY,

AND IN EVERY PART OF THE GLOBE,

THIS ATTEMPT

TO BLEND RELIGIOUS FEELING

WITH PHILOSOPHICAL KNOWLEDGE,

IS HUMBLY DEDICATED

BY HIS OBLIGED AND GRATEFUL SERVANT,

THE AUTHOR.

ERRATA.

Page 30, 5th line of note, for 33° 31′ 30″ read 23° 31′ 30″.
124, line 14, for *Enlinement* read *Enslavement*.
249, — 9, — *carbonet* .. —— *carburrut*.
288, — 24, — *Monsecia* .. —— *Monoecia*.

Gift
J. H. Russell
6-29-73

PREFACE.

MANY and various are the publications continually issuing from the press, professedly compiled for the use of the rising generation, no small number of which are characterized by considerable merit; nevertheless, the Author of the following pages thinks that a Volume containing the Elements of the various branches of Philosophy and Science, having for its distinguishing characteristic the enforcement of Christian principles, to be still a desideratum.

It has therefore been the object in this Work to plant beside the tree of knowledge the tree of life; to improve every fact and circumstance appertaining to the physical world, by a constant reference to the spiritual one; and to look through nature to the Divine Author and Preserver of all things.

In furtherance of such an object the Author has ventured to call to his assistance "Divine Poesy," from a conviction that many of the sentiments necessary to be introduced, if put forth in ordinary prose, would be deemed neither new nor interesting, but that, exalted by the more glowing language of poetry, they would shew themselves under new aspects and greater advantages. With respect to the execution of this part of the Work, it has been the principal endeavour to avoid any thing like an excess of poetical embellishment, the Author contenting himself with merely the correct expression of such ideas as might be suggested by the several subjects, without any ambition for poetic notoriety.

It will be found on reference to the Work, that the Poetical Illustrations principally refer either directly or indirectly to the chapters to which they are attached, but it has been thought better to follow general rather than particular references. The main topics have been the POWER, WISDOM, and GOODNESS of the Creator — the beauty of Holiness — Prayer — Praise — the emptiness of mere human wisdom — and the fulness and perfection of that which is from above; and it is trusted, that the manner in which such subjects have been treated, will afford a pleasing relief to the other parts of the Work, and be the means of powerfully directing the attention of the youthful reader to those divine truths, which are the great sources of earthly comfort, and unerring guides to felicity in heaven.

With regard to the subjects treated of generally. In Natural History are exhibited the more striking characteristics of the mineral, vegetable, and animal kingdoms. In the Zoological portion some of the instances of Divine Wisdom and Design will be found to have been compiled from the inimitable Paley, and no apology, it is presumed, is necessary for their introduction. In the Geographical part, the object has been to afford addenda to the usual elementary books on the subject, by giving the present moral and intellectual state of the world. In that portion of the work embracing the Elements of Physics, it has been the aim to keep to the less abstruse and difficult parts of science, and to avoid the introduction of any thing that might not be readily comprehended; for this reason nearly all the experiments illustrative of Natural Philosophy, may be performed without the aid of regular *apparatus, an advantage* evident and important.

INTRODUCTION.

GOD.

I.

Eternal Lord of light and life; the soul
Of nature and the Deity of all,
Whose spirit bending o'er the wondrous whole,
Suffers unwill'd, no flower or bird to fall:
Can the proud eye look upwards to yon dome,
Or view the rich array spread forth below,
And not feel pledges of a dearer home,
That make the bosom leap, the spirit glow
And stretch its hopes far into eternity,
Till like the Patriarch's dove it rests great Lord on Thee

II.

On Thee, its ark of perfect holiness,
With tokens of its everlasting peace,
And certainty of fadeless joy to bless
It in a higher state when time shall cease.
The stars shall burn: those living orbs were fed
With pure effulgence from thy vital ray,
To light us deep into thy essence, shed
Abroad through earth and air by night and day:
Filled with that glory would my spirit soar,
And although *trembling*——yet, *exultingly* adore.

III.

For Thou art all in all—the First,—the Last,
Creator, Ruler, Great High Priest, and King!
Thy works—how fair! thy power—the mighty blast
Bears it from pole to pole upon its wing!
Thy kingdom is the universe, enshrined
By the ten thousand suns that gleam above;
Thy temple is *the* all immortal mind,
Delivered from its tumults by thy love,
And though thy presence beams throughout all space,
Yet is the human heart not less thy dwelling place.

IV.

Philosophy hath kept the patient watch
Through many an age in vague uncertainty,
And endless speculation, but to catch
From Thy fair works some transient glimpse of Thee
But, ah! how dim is e'en yon orb of light,
And all the splendour of ethereal fires;
Though they do seem to daze the mortal sight,
And the wrapt soul their effluence inspires;
To the pure glory that Thy love has given,
To cheer the sinking soul, and lift it unto heaven.

V.

The wise have looked for Thee from year to year,
Amid the boundless sky or far stretched main:
Thy holy presence could not there appear,
And cold abstraction pondered long in vain;
Yet Thou hast deigned to converse with man,
From the bright sky —— the Star of *Bethlehem shon*
The mighty shook, and royalty looked wan,
Yet WISDOM still rejoiced and followed on;
Till at the manger's foot it paused to see
The fulness of Thy glory——and of THEE.

VI.

Millions of suns blaze proudly from yon sky,
Millions of orbs move round them in the full
And perfect law of glorious harmony;
All fair, and bright, and calm and beautiful!
Thy *peace surpasseth all;* and daily bends
With feelings and sensations deeper far
Than the bright blue which through the heaven extend
And more exalted than the loftiest star;
Lifting mean man beyond the proudest sphere,
And whispering to the soul, that THOU art ever near.

ASTRONOMY.

———— Divine Philosophy!
That tamest the rugged breast, and bringest down
The wisdom of the heavens to dwell with man,
Or liftest up the heart unto its God:
I follow thee through all thy glorious paths,
Amid the distant worlds or sparkling orbs
That glow on high; or through the rich array
Of this fair earth, 'mid shrub, and tree, and flower;
Wherever beauty dwells, or wisdom shines,
Or love or glory springs; and there would turn
To the celestial Lord of life and light,
With praise and admiration on my tongue.

CHAPTER I.

Introduction. Definition. Authority. History. The Patriarchs. Josephus. Pillars of Seth. Noah. Fo-hi. Chaldea and Egypt. Temple of Belus. Zoroaster. Monument of Oxymandias. The Phœnicians. Greece. Hesiod and Homer. Thales. Pythagoras. Aristarchus. Eratosthenes. Hipparchus. Ptolemy. The Arabians. Albategnius. Ebn Younis. The Saracens. Arzachel and Alhazen. Europe. Alphonso. Roger Bacon. Muller. Copernicus. Tycho Brahe. Galileo. Huygens and Cassini. Newton. Flamstead. Piazza. Harding. Olbers. Herschel.

The science of Astronomy is, above all the other sciences, calculated to excite in the mind the most lively ideas of the Divine Being: as it affords the sublimest views of his unerring wisdom, *and gives us* the grandest specimens of the *beautiful harmony* which pervades his works;

it is in fine a glorious introduction to all his perfections; for we perceive in the contemplation of the heavenly bodies immensity of operation, guided by the strictest regularity: we find revolutions intricate and comparatively complex, resolving themselves into paths the most simple: thousands of orbs wheeling about each other without the smallest confusion, guided by the hand that formed them, and upheld through the infinitude of ages, in the perfect concord of never-failing love. Astronomy may also be considered as the proudest triumph of Philosophy and Human Reason; for it not only convinces the atheist of the existence of a God, and lifts the creature to its Creator on wings of sublime intelligence, but it is also the most perfect, and the most useful, as well as the most ancient, of all the sciences. In regard to its usefulness:—by its aid the mariner is enabled to penetrate unknown climes, to steer his bark with confidence through unknown seas, and to transport the surplus of one nation to increase the comforts of another. A science, then, possessed of the greatest usefulness, the highest antiquity, the utmost sublimity, and reaching among others the nearest to perfection, must be an object of the most transcendant worth that can occupy the attention of the human mind.

ASTRONOMY demonstrates to us the laws by which the heavenly bodies are governed; explains their motions, periods, eclipses, and *magnitudes*, and is applied to Geography, Chronology, and Navigation. Its history commences

with the history of the Creation; its authority is derived from God himself, who said "let them be for signs, and for seasons;" and it is therefore certain, that the human race never existed without a knowledge of Astronomy among them. The long lives of the Patriarchs afforded such an excellent opportunity of observing the celestial bodies, that we cannot but suppose the science of Astronomy to have been considerably advanced before the flood. Josephus ascribes to Seth, and his posterity, an extensive knowledge of the science; and speaks of two pillars, one of brick, and the other of stone, called the pillars of Seth, upon which the principles of the science were engraved, and he states, that the stone one was entire in his time.

If we refer to Profane History, the origin of Astronomy may be traced either to Chaldea or Egypt; in fact, the early histories of all nations exhibit traces of Astronomy among them. Traditionary accounts exist among the Chinese, of their having been taught this science by their first emperor Fo-hi, who is supposed to have been the same with Noah; and among them the discovery of the pole star, and the invention of the sphere, is ascribed to Hong Ti, grandson of the former. The Americans also were not found unacquainted with Astronomy; for they applied it to the division of time, like all other nations, though they made use only of the solar, and not of the lunar motions. For a connected history of the science, we must recur again to Chaldea or *the Egyptians*. The Chaldeans boasted of *their Temple of Belus*, and of Zoroaster, whom

they placed 5,000 years before the destructi
Troy. The Egyptians boasted of their M
ment of Osymandias, in which we are told
a golden circle 365 cubits in circumfere
divided into 365 parts, according to the da
the year.

From Chaldea, Astronomy most prob
passed among the Phœnicians, who seer
have been the first who applied it to the purp
of navigation; they steered their ships b
star which lies contiguous to the north
called the pole star, and being adventurou
their voyages, became masters of the sea,
of almost all the commerce in the world. A
nomy is also coeval with the earliest histo
Greece; several of the constellations are
tioned by Hesiod and Homer, two of the
ancient poets in the world, who lived about
years before Christ. Thales the Milesian gr
improved the science, and predicted an ecl
which raised him very high in the estimati
his countrymen. Anaximander, Anaxim
and Anaxagoras, contributed still further t
advancement of Astronomy; the last of
predicted an eclipse, and taught, that the
consisted of hills, vallies, and water, lik
earth. His contemporary Pythagoras, how
exceeded all who went before him, in his k
ledge of Astronomy. Pythagoras not only ta
the true doctrine concerning the universe
motions of the planets, but formed variou
potheses which have been demonstrated i
discoveries of the moderns.

happened 323 years before Christ, the science continued to advance rapidly. Aristarchus strenuously asserted the Pythagorean system; Erastothenes, 250 years before Christ, measured the earth by means of a gnomon, and is said to have invented the armilliary sphere; he also determined the distance between the tropics, and measured a degree of the meridian. Hipparchus, 150 years before Christ, discovered that the orbits of the planets were not circular, but elliptical, and gave a catalogue of more than 1000 of the fixed stars, with their latitudes and longitudes. From Hipparchus to Ptolemy, who flourished in the first century of the christian era, but little progress however was made in the science. Ptolemy indeed invented a system which was implicitly followed by all nations, till within about 300 years of the present period. This system had the earth for its centre, and was in various other particulars absurd; nevertheless, Ptolemy may be said to have advanced the science, by his collection and care of ancient observations.

Astronomy from this time seems to have made a pause, and it was not till above 800 years after Christ, that we find its cultivation at all attended to; and even at that period we must turn to the Arabians for its revival. The Caliph, Al Mansur, was the first who introduced a taste for the sciences into his empire. His grandson, Al-Mamum, who ascended the throne in 814, made *many astronomical* observations, and from this *time Astronomy* was assiduously cultivated by *the Arabians.* Albategnius, who flourished

880, was one of the most celebrated of their
tronomers, as was also Ebn Younis, astrono
to the Caliph of Egypt; who observed th
eclipses with great care, and made several v
uable deductions from their occurrence. Am
the Saracens, Arzachel, a moor of Spain,
Alhazen, his contemporary, advanced the the
of refractions, wrote upon the twilight,
height of the clouds, and the phenomenon of
horizontal moon; while Ulug Beg, grandson
the famous Tartar Prince Tamerlane, is reporte
have constructed instruments of a very large s
particularly a quadrant as high as the churcl
Sancta Sophia at Constantinople, for the
vancement of the science. We are indebte
the Arabians also for the present form of tri
nometry, and for our numerical charact
During the greater part of this time, Europe
mersed in the deepest ignorance and barbar
continued not only unacquainted with As
nomy, but with every other science. Howe
about the year 1230, the translation into L
of the works of Aristotle, and the Astronom
Treatise of Ptolemy, by order of the Emp
Frederick the Second, of Denmark, began
revive the spirit of astronomical enquiry.
phonso, King of Castile, and Roger Bacon,
English monk, may also be accounted ins
mental in rescuing this, and other sciences, fi
oblivion. After these, John Muller, a Fran
nian, about the year 1471, and John Werne
clergyman, in 1500, published many treatises
this science and the Mathematics. At
NICHOLAS COPERNICUS appeared, who

conceived doubts concerning the Ptolomaic system which till that time had been implicitly followed, and of all the hypotheses that had preceded him, except that of Pythagoras, which he soon demonstrated to be the true system of the universe. Copernicus died in 1543, and after his death the science advanced rapidly. Tycho Brahe quickly followed, and attempting to improve upon Copernicus, in his desire to reconcile some passages of Scripture with his doctrine failed; but, nevertheless, made several useful discoveries. Kepler came after Tycho, and ascertained for a certainty, that all the planets move in *elliptical* orbits; that the squares of the times of the revolutions of the planets, were to one another as the circles of the greater axes of their orbits, and that their motions are sometimes faster, and sometimes slower. The invention of telescopes, in the beginning of the 17th century, which although not absolutety an invention of Galileo,[1] yet they were so far perfected by him, as to enable him o discover the inequalities on the moon's surace, Jupiter's satellites, the ring of Saturn, and

[1] The discovery of the telescope is attributed to the ildren of Zachariah Jansen, a spectacle maker of eddleburg in Zealand, who, playing with some nses, accidently placed two in such a manner, that weather-cock of the church was both enlarged, d brought nearer to their eyes. Having communi-ed this *singular* fact to their father, he made indeed *first telescope*, by placing two lenses upon a board. *leo however* improved so much upon this, that *allow him* the whole merit of the discovery.

the spots on the surface of the sun; by means of which he discovered the revolution of that luminary round his axis. About the year 1638, Hevelius flourished at Dantzic, and furnished a more complete catalogue of stars, than any that had before appeared. Huygens born in 1629 and Cassini in 1625, discovered the satellites of Saturn; and the illustrious NEWTON demonstrated, from physical considerations, the motions by which the heavenly bodies are regulated.

To advance Astronomy to its greatest limits, nothing now appeared wanting but the invention of new instruments, or the improvement of old ones; and the science is indebted to this country for some of the greatest improvements in astronomical instruments that have been made. Graham carried the accuracy of his instruments to a degree that surprised every one, and other Englishmen continued to make further improvements. In 1675, Mr. Flamstead was appointed the first Astronomer Royal at Greenwich, and he kept an almost perpetual watch, for the space of 44 years, on the celestial phenomena. In 1719, Dr. Halley succeeded Flamstead, and gave to the world the astronomy of comets, and a catalogue of the stars of the southern hemisphere. Dr. Bradly, who succeeded him, was superior as a practical astronomer, and published several useful tables and observations. [2] The discoveries of Herschel, Piazzi, Hard-

[2] *In 1639,* Horrox first observed in England the *transits of Venus* over the disk of the sun. Halley *pointed out the facility* these transits would afford, of

ing, and Olbers, form a new æra in Astronomy, which brings its history down to the present period, the former of these gentlemen, by his great discovery in augmenting the power of the telescope, opened in the heavens views altogether unlooked for, and unfolded scenes which cannot fail to excite our wonder, reverence, and admiration towards the Creator. By their aid five new planets have been discovered, and the sense of human vision has been enabled to look upon myriads of sparkling orbs, of which the former generations of the earth scarcely formed an idea; and thus man is taught to feel the immensity of Creation, the wisdom of the Creator, his own littleness, and in the contemplation of such wonders,

Should turn from things terrene and from the strife
Which with a serpent's coil environs life,
Should strive to bend in awe the trembling knee,
Raised and not *lost* in the immensity;
And seek at once earth's turmoils from him thrown,
The brightening presence of the HOLY ONE,
That breathes a life to hopes that cannot die,
And lights with joy a drear eternity.

---

ertaining with greater precision the parallax of the and consequently the distances of all the planets that luminary. They were accordingly observed great accuracy, in 1769, by astronomers sent for important purpose, to the island of Otaheite, on outh Sea, at Wardhus in Lapland, and at Cajanein Finland. Not long after Dr. Maskelyne, in periments on the Grampian Hills, and Humbolt, great mountains of North America, fully es ed the attraction of the earth. Whilst, Lalande, by his nephew, Le François, completed a e of above 30000 stars.

CHAPTER II.

Look upwards grovelling dust! behold yon pure
And spangled concave of etherial blue,
Where the eternal writes in words of fire,
Wisdom and power, and glory, ye are mine!
Is not this glorious language of the stars,
This high and holy eloquence of heaven,
Acknowledged through the universe?—Yet man
Sleeps tamely through the watches of the night,
Or walks beneath the radiance of the moon,
And the rich glittering of ten thousand suns,
Unconscious and uncharmed.—Awake! awake!
Thou child of immortality, and turn
The eye of rapture upwards; soar above
The blazon'd hosts on pure religion's wing,
And pay thy homage to the LORD OF ALL!

Definition of Circles. Pole Star. Signs of the Zodiac.

To the uninformed spectator, the earth appears an extended plain, round which, in 24 hours, the sun, moon, and stars, seem to revolve. When the eye is raised to the heavens, it perceives a vast hollow hemisphere of an unknown extent, which, at a certain distance, and on a level with the eye, appears to be met by the earth; this boundary to the sight is called the *sensible* horison; the *mathematical* horison has the centre of the earth for its centre. At night we behold this vast concave studded with innumerable shining bodies, which we call *stars, and these* appear to be constantly changing *their positions*; new stars being seen con-

ally to rise above the eastern horison, and
passing above our heads, to sink in the
. If we keep our eyes fixed in the north,
soon perceive that many stars in that quar-
lo not sink at all, but continue to move in
es round a certain point; this fixed point is
d the *North Pole*, and is distinguished by
ar of considerable magnitude, called the
Star, which appears perfectly stationary.
milar fixed point in the hemisphere, below
feet, called the lower hemisphere, round
h the stars, visible to the inhabitants of that
of the world, revolve in the same manner,
lled the *South Pole*: an imaginary line pass-
through the centre of the earth, and con-
ing these two points together, is called the
s of the World. Besides this imaginary
there are several others, which are de-
ed by astronomers on the upper and lower
isphere. A great circle dividing the celes-
sphere into the said upper and lower hemi-
res, is called the equator; and this, as well
ll other circles, is divided into 360 equal
s, called degrees; the degrees are each di-
d into 60 other equal parts, called minutes,
each minute partakes of a further division
0 parts, called seconds. The next great
e is called the meridian, and is not fixed and
rminate; as it is supposed not only to pass
ugh the poles, but also through that point in
heavens directly over the head of the ob-
er; this point of the heavens is called the
ith; the opposite one the Nadir; the terres-
meridian, is the one geographers measur

the longitude from, who generally fix upon that on which the metropolis of their own nation stands; thus, England has the meridian of Greenwich; France, that of Paris.

Another great circle described in the heavens is the ecliptic, which in other words is the orbit of the earth; this passes through certain signs, among those of the heavenly bodies, called the 12 signs of the zodiac. The ecliptic is the *apparent* path of the sun, as it appears from the earth; but is, in *reality*, the course of the earth itself among the stars; if great circles be imagined to cut the ecliptic at right angles, these will intersect each other at nearly 23 degrees and a half from the poles of the world; these points of intersection are called the poles of the ecliptic. Other two points, where the ecliptic touches the tropics, are the solstices, on which the sun appears for a short time stationary, twice during the year, at midsummer and midwinter; other two points are where the ecliptic cuts the equator; when the sun is on these, which are called the equinoxes, the days and nights are of equal length in every part of the world: these equinoxes, or equinoxial points, are those of Aries and Libra: the solstices are those of Cancer and Capricorn; four small circles are also added to the above. At 23 degrees north of the equinoxial line, or equator, a circle is described which is called the *tropic of Cancer;* and at 23 degrees south of the equator, is another circle called the *tropic of Capricorn: when the sun* is directly over either of these *tropics, it illuminates* exactly one half of t

globe, and owing to the axis of the earth being inclined to the plane of the ecliptic 23½ degrees, its rays extend exactly 23½ degrees beyond the north pole, during our summer, and 23½ short of the south pole: while, during our winter, its rays fall 23½ *short* of the north pole, and the same number *beyond* the south pole: now these extreme boundaries of light and darkness, mark out the polar circles on the globe, and the polar circles in the heavens correspond exactly with them, as do the other circles which have been described; the circle which surrounds the north pole is called the *arctic* circle, that which is near the south pole the *antarctic* circle.

The zodiac before alluded to, is a circle or belt in the heavens, about 16 degrees broad, beyond the limits of which the planets never deviate. It was ingeniously divided by Cleostratus Tenedius, as Pliny informs us, lib. ii. c. 8. into 12 signs, expressive and emblematical of the various phenomena of the year. They are Aries, ♈ (the Ram;) Taurus, ♉ (the Bull;) Gemini, ♊ (the Twins;) Cancer, ♋ (the Crab;) Leo, ♌ (the Lion;) Virgo, ♍ (the Virgin;) Libra, ♎ (the Balance;) Scorpio, ♏ (the Scorpion;) Sagittarius, ♐ (the Archer;) Capricornus, ♑ (the Goat;) Aquarius, ♒ (the Water Bearer;) and Pisces, ♓ (the Fishes;) the first six of these are the northern and summer signs, the other six, the southern and winter signs. Now the first three signs, the Ram, the Bull, and the Twins, *which correspond to the months March, April, and May*, were expressive of the fe*cundity of* that season; while the Crab d

noted the sun's retrogade motion at mid-summer. The Lion was emblematical of the fierce heat which generally ensues after that period; the Virgin, with ears of corn, seemed to signify the harvest; the Ballance shew the equality of the days and nights in autumn; the Scorpion, the venomous diseases at the fall of the leaf; the Archer denoted the hunting season; the Goat, remarkable for climbing, expressed that the sun was again mounting the Zodiac; the Water-bearer represented the setting in of the wet season in those parts of the world; and Pisces the fishes; was emblematical of the fishing season. In addition to these 12 signs, imagination has figured various devices among the groups of stars visible to the naked eye, for the purpose of their being readily referred to, and easily distinguished. The number of these, in addition to the 12 already described, is, in the upper or northern hemisphere, 36; and in the lower or southern hemisphere 32. The division of the stars into constellations, was doubtless in accordance with some remarkable periodical occurrences, which correspond with the particular situation of the stars: it appears, that the star to which the Egyptians gave the name of Thaut, or the Dog, annually gave warning, by its appearance, of the rise of the Nile at its proper season. The constant occurrence of such a fact, ingenuity was likely to improve; and this, with the aid of Mythology *and Poetry, has* embellished the heavens with *imaginary creatures.*

CHAPTER III.

How beautiful!
The fixed eternal harmony that reigns
Among the spheres!—how glorious the sun
Throws forth his vital light on all, and holds
Each silent orb in vassalage and awe.
Thousands of years have passed, millions have gazed
Upon their courses, and the sage's eye
Hath followed through the multitude of years,
And lost its fire in looking on them. They
Are still the same, still beautiful, still bright,
And have beheld and will behold in calm
Contemptuous grandeur the vain eye of man
Scanning their ways. Myriads on myriads
Of daring souls will strive to pierce the veil,
That wraps them from the finite mind; but time
Cannot reveal them fully. They will still
Shine on in holy mystery, a joy
To the drear earth, and to the sacred night
A blessing and a glory.

The Planets considered. Egyptian Theory. Ptolomaic. Copernican. Distances of the Planets. Gravitation. Centrifugal and Centrifugal Forces, &c.

We have hitherto attempted to define certain imaginary circles, drawn by astronomers, on the celestial sphere, and spoken of the manner in which the stars are grouped; at a further opportunity we shall attempt to give a more detailed account, of all that is worthy of remark, relating to the fixed stars; but, for the present, *be content to* introduce the reader to certain *shining bodies*, which have, from the earlies

periods, been the subject of enquiry and researc among mankind; and which, in consequence their moving among the other stars, cannot l grouped among them. These shining bodi are called planets. From the most dista period of time, till within the last century, s only were numerated, but by the aid of th modern astronomical instrument, the telescop five others have recently been discovere These eleven planets, and the satellites moons attending them, with the comets and t sun, round which all of them revolve, seem complete what is called the Solar System. T arrangement of this system, its peculiariti and the laws by which it is governed, will the subject of the present chapter; succeedi ones will enable us to discourse upon ea planet individually.

We have seen by the foregoing chapters, th Astronomy, although cultivated more or less almost every country, barbarous or civiliz was for a period of nearly 6000 years but ve imperfectly understood. One man alone, t philosopher Pythagoras, ventured ideas whi corresponded with the truth; but those ide although subsequent enquiries have proved th correct, were at that time unsupported by th necessary demonstration which ensures conv tion. All other hypotheses were absurd in extreme, and it is remarkable, that the m absurd gained the greatest number of adheren *and were the* most tenaciously defended. T *ancients had* indeed noticed the planets, a *applied the* heavenly bodies to the division *time, and the* purposes of navigation; but, ne

eless, could not account for certain appear-
ces, which they every day witnessed in the
avens. According to the theory of the Egyp-
ns, the earth was supposed to be immovable
the centre of the universe, about which re-
lved in order:—1st. the Moon; 2nd. the Sun;
d. Mars; 4th. Jupiter; 5th. Saturn; while
out the Sun revolved Mercury and Venus.
he system of Ptolemy, who lived in the first
ntury of the christian æra, was somewhat
fferent to this, but equally as absurd. Ptolemy
pposed the earth to be in the centre, and at
st, while about it revolved; 1st. the Moon;
en Mercury; then Venus; then the Sun; then
lars; Jupiter, and Saturn: beyond Saturn he
laced the firmament of the fixed stars; and
bove these two solid christalline spheres; one
oving from east to west; the other from north
south; the whole of this he enclosed in
nother sphere, which he called the "primum
obile" or first mover: this arrangement he
pposed produced all the motions of the planets,
nd all the appearances they make to the senses.
ythagoras, however, who lived before Pto-
my, had, as we before intimated, true notions
oncerning the system of the universe; these
incided with those of the present day, which
e absolutely demonstrated. The system of
ythagoras was nevertheless rejected, by all
es, until revived by Nicholas Copernicus, in
e 16th. century. This system has been in-
fferently called the Pythagorean, the Coper-
an, and Solar System. It consists of the
n in the centre, with the planets moving round

him, in orbits slightly elliptical from w
east, in the following order. The Sun
centre, Mercury, Venus, the Earth, Mar
piter, Saturn, and the Herschel. This s
also includes the comets in very narrow ell
orbits, and four other planetary bodies, n
between the orbits of Mars and Jupiter;
supposes the earth to turn round its axis, a
Moon to move round her as she flies al
her orbit, as do the satellites of the other p
some of which have as many as si
seven to attend them. Beyond the wh
these are the fixed stars, which are suppo
be suns, having planets revolving round t
a similar manner. This disposition of the
accounts for all the apparent motions
heavenly bodies, and agrees exactly with
tial observations, which prove its tr
absolute demonstration.

The mind of man, ever anxious to acco
the difficult and surprising, has succeede
deductions drawn from simple facts, in
lating to the utmost nicety the perio
measuring the diameters, and in determini
distances of the planets, and even of thei
lites. The method of investigation used
termine the distance of a planet, is the sa
that applied to find out the distance
object within our view upon the earth;
a ship coasting along the shore, passes a
ject, such as a light-house, if the obje
near her line of course, she very quickly
it behind her; but if the object be mar
from her line of course, she appears to

abreast of it, perhaps the whole of the day, although sailing at a rapid rate: this would enable us to judge of the distance, if the diminution of the object, in point of size, did not also convince us. Now upon this very fact or principle, united with a discovery of Kepler's, and other information, gathered at observations taken during the transit of Venus over the disk of the Sun, in 1769 and 1781, do philosophers determine the distances, and measure the diameters of the planets.[3]

It has been stated, that the planets move round the sun in orbits slightly elliptical. This is in consequence of a certain principle, called *attraction*, which has been demonstrated by Sir ISAAC NEWTON, to determine all bodies to each other, as the needle is determined to the magnet. This principle is as a chain in the works of Creation, and it is owing to its influence that the world remains a solid ball;

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[3] This discovery of Kepler's was, that the squares of the periodical times of the planets, are as the cubes of their mean distances from the sun: that is to say, if you multiply the numbers expressing the times of going round, each by itself, the products will be to one another in the proportion of the average distances multiplied each by itself, and that product again by the distance:—thus, if one body take two hours, and is five yards distant, the other being ten yards distant, will take something less than five hours and forty minutes. Knowing therefore the distances of one planet, it is easy to find out the distances of all the rest, because the squares of the periodical times of the planets, are as the cubes of their mean distances from the sun.

that those people who live at the antipodes of the world, are able to walk with their feet diametrically opposite to ours, and that a stone falls to the ground. We know nothing of the cause of this remarkable property in all matter; *that* must be resolved into the will of the all wise Being; but that it does exist, is deduced not only from speculation on the nature of things, but from actual experiment; for when the astronomers, selected by the French Government to measure a degree of the meridian, near the equator, made their calculations, it was found, that the attraction of the great mountains of Peru had such an effect on the plumb line of one of their large instruments, as to draw it seven or eight seconds from the true perpendicular. To make this subject easily understood, we must suppose that matter is of itself perfectly passive, and that if a body were put in motion, it would continue to move in the same direction for ever, unless some active cause operated to stop it. Now as we know by the evidence of our senses, that a stone thrown upwards into the air, does not remain there, and that the planets continue moving in the heavens, we must suppose, in the first instance, a cause for the stone falling back again to the ground, and also a force to counteract that which first of all put the planetary bodies in motion. Two powers then must really exist to produce these effects. Such then have been called the centrifugal and *centripetal forces*. The first, which is the *impulse to move*, impressed upon the body or planet, *is called the centrifugal* force; while the

other, which is that inherent principle, *gravity*, already described, is called the *centripetal* force. Now the first of these forces has the tendency, if uncontrouled, to make the planets fly off in a right line through the immensity of space; but the controuling influence of the other, which would alone draw them to the centre of the sun, meets it and carries them in an orbit nearly circular about that body, much in the same manner as a stone, attached to a string, is whirled round by the hand, in which the motion given at the onset to the stone, would represent the centrifugal force, while the string itself would represent the centripetal power, the stone having a tendency impressed upon it to fly off in a tangent, is prevented by the string, which causes it to move in a circle.

But we have said that the planets do not move in exact circles but in elliptical orbits; this is accounted for by considering, that the power of gravity which draws them towards the sun, varies with their distance from the sun's centre, exactly in proportion of the squares lessening, as the distances increase. At two diameters from the sun's centre, it is four times less than at one; at three diameters, nine times less: this goes on lessening in the same ratio, however great the distance may be, but is never entirely destroyed: now it is proved by astronomical observations, that the motion of the heavenly bodies is slower at one part of their orbit, and quicker *in another*, in the same manner as a *body's motion on* the earth would be slower o *quicker according* to the distance from the poi

it was drawn towards, providing it was drawn by a force acting in the proportion to the squares of the distance: therefore, the planets are attracted towards the sun, by a force that varies according to the same proportion in which gravity varies; and they must consequently move in elliptical orbits round the sun, which is placed in what is called one of the foci of the ellipse, or a point nearer one end than the other of the curve.

The orbits of the planets are observed slowly but continually to change, through the influence of the sun; and the obliquity of the ecliptic to the equator, has been found to decrease gradually from the time of the earliest observations.[4] These and the mutual attractions between the sun and the planets, and between the planets and their satellites, gave rise to deviations from the simple line of the ellipse, and produced many irregularities in the calculations of the times and motions of the bodies, that compose the system of the universe. This seemed at first to baffle every attempt to form a perfect system, or to compute the precise order of their continual change; but the extraordinary powers of investigation, applied to the subject by the modern improvements in mathematics, have enabled us

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[4] This decrease has been found by astronomers to be

2000 years B. C.	24°	0′	0″
250 B. C. by Erastothenes	23	50	0
A. D. 880 by Albategnius	23	35	1
A. D. 1587 by Tycho Brahe	23	31	30
At the present period it is only	23	28	0

at length to reduce even the greatest of these irregularities to order and system, and to unfold one of the most wonderful truths in all science; namely, that by certain necessary consequences of the simple fact, upon which the whole fabric rests—the proportion of the attractive force, to the distances at which it operates—all the irregularities before mentioned, are themselves subject to a certain fixed rule, and can never go beyond a particular point, and must *begin* to lessen when they have reached that point, and *continue* to lessen, till they reach another point, when they begin again to increase; and so on, until the time that He who called all things into being with a word, shall pronounce the eternal fiat, "be no more."

The power and principle of gravitation, thus understood, extends through the immensity of space, and regulates the motions of the incalculable millions of systems and worlds, enjoying the favor and beneficence of an all wise and all merciful Creator. The same principle is also found to rule in the same manner, and by the same immutable law, each branch or member of creation separately; it is the cause of the tides in the ocean, for it is gravitation that attracts the water towards the sun and moon; and the oblate figure of those planets, which turn rapidly round their axes, is deducable from the same ruling cause, for the power of gravity, combined with their spinning motion, flatten them at *the poles*, and make them bulge out *towards the middle*, in the same way as a

hoop would, if twisted into motion, in the manner a child causes a halfpenny to spin.

Thus does the theory of universal gravitation simplify the system of the world, whilst, at the same time, it connects all the phœnomena of the heavens, which before its discovery appeared wholly unconnected; and although many have laboured to overturn the principles upon which it is founded, yet, demonstrated by a series of the most accurate geometrical conclusions, it bears unshaken the test of the most rigorous calculations; and gives to succeeding generations the name of Newton, the pride of the country which gave him birth, and the admiration of all others, surrounded with a halo of philosophical glory.

Having thus considered the general arrangement of the Solar System, and the laws by which it is governed, we shall now offer a few remarks on the Sun, which is the centre of the whole, and on the several Planets individually.

THE SUN.

——————— Soul pervading orb
Too bright to gaze upon, too fair to shun;
Say, hast thou ever beamed upon the eye
And not into the bosom, didst thou e'er
Rise on a tribe or nation, though amid
The barren desert or the pathless wild,
Without imparting cheer?—From the deep
Impenetrable woods where man's proud foot
Ne'er trod to tyrannize, the freedom roar
Of the bold lion greets thee, and his rage
Dies as thy glory brightens.—Beautiful
Beloved master-piece of the most High,
Fain would I fall to earth and worship Thee,
Did I not know *thy* maker also *mine*.
MINE—my soul is now above thee orb,
My thoughts are farther than thy beams can pierce;
They are of brighter orbs than even thee,
And make thy light more precious, and the shade
When thou hast left us more endurable:
For through the dimmest hour, the meanest heart
The SUN OF RIGHTEOUSNESS is piercing now,
The web has been withdrawn, the spider film
Clear'd from the sense, and immortality
Clothes the joy'd heart in radiance of its own
And a more glorious sunshine; that will beam
With undiminished lustre, when thy light,
Hath passed away upon eternity
Like a brief exhalation, and thy form
Hath vanished like a bubble in the stream!

CHAPTER IV.

Distance of the Sun. Motion on its Axis. Solar Spots. Opinions of King and Herschel.

This *glorious* body, which appears to us the *soul of the universe*, and the mighty agent use *by the Deity*, to bring the produce of the ea

to perfection, is of a spheriodical form; its diameter is 883,250 English miles, and it is 95 millions of miles distant from our earth, and its axis is found to be inclined to the ecliptic, in an angle of about 82½ degrees. When viewed through a telescope, several dark spots are visible on its surface, which are of various sizes and duration. From the motion of these spots, the Sun has been found to move round its axis, in 25 days 10 hours, which is two days less than its apparent revolution, in consequence of the earth's motion in its orbit in the same direction: these spots and certain appearances, connected with them, have been the subject of enquiry among astronomers for many years, and various hypotheses have been advanced to account for them. They are seen to increase and decrease in magnitude, to change their places, to appear at one time luminous, at another dark: sometimes one spot divides into two or three which, recede from each other with prodigious velocity, and sometimes two or three spots are seen to meet and unite in one. These appearances were entirely unknown before the invention of telescopes: the spots are said to have been discovered in the year 1611, by Galileo. The solar spots appear to have a motion, which carries them across the sun's disk: every one of which that continues long enough without being dissolved, appears to enter upon the sun's disk, on the east side; to go from thence with a velocity continually increasing, till it has gone half its way, and then to move slower and slower, till it goes off on the west side; after which

disappears for about the same space of time that it spent in crossing the disk, and then enters upon the east side again. The apparent irregularity in the motion of the spots, is purely optical, and is in such proportion as demonstrates them to be carried round equatably or in a circle, the plane of which continued, passes through or near the eye of the spectator on the earth.

The Sun was long considered, from its constant emanation of heat and light, as an immense globe of fire. Mr. King, in 1788, supposed the Sun to be a planet like our own, but immensely large, and that the spots we alluded to were the body of the Sun seen through an atmosphere of his own; and that the Sun is not necessarily subject to burning heat, but is an inhabited globe, like our own planet; and that the rays of the Sun only produce what is called heat, when they come in contact with planetary bodies, or upon what may be called a calorific medium. Dr. Herschel, in a paper read to the Royal Society, in the year 1794, considers the Sun as a magnificent habitable globe, surrounded by a double set of clouds; those that are nearest its opaque body, being less bright, and more connected together than those of the upper stratum, which form the luminous *apparent* globe we behold; he also supposes this luminous matter to be of a phosphoric nature, having several accidental openings in it, through which we see the Sun's body, or the more opaque clouds beneath, and *that* these openings form the solar *spots, the subject* of so much speculation and *conjecture.* The Sun viewed in this light, a

pears to be nothing else than a very eminent, large, and lucid planet; evidently the first, or, strictly speaking, the only primary one in our system, all the others being truly secondary to to it. Its similarity to the other globes of the solar system, with regard to its solidity, its atmosphere, and its diversified surface, with its rotation on its axis, and other similarities, lead us to suppose that it is most probably also inhabited, like the rest of the planets, by beings whose organs are adapted to the peculiar circumstances of their situation.

MERCURY.

Faint is thy light fair Mercury,
And soon thou turn'st from human gaze;
As if the Monarch of the sky,
Withheld from thee his vital rays:
Yet, oh! that orb of light supplies,
Thee with a glory greater far,
Than ever yet he bade to rise
Upon a brighter star.

'Tis even thus with souls that shine,
'Mid piety's subduing beam,
Not bearing less the ray divine,
Though lustreless and dim they seem:
Yes meek and unobtrusive still,
They shine but faintly to this sphere,
But yet to Him whose glories fill,
Both heaven and earth—how very near.

CHAPTER V.

Mercury is first planet in the order of the *tem, being* nearest to the Sun, his distance

from that luminary is computed to be 37 millions of miles, and he moves in his orbit at the rate of 105 thousand miles within the hour, completing his revolution which is the period of its year in 88 of our days. Mercury appears small to the eye, but emits a very bright white light, and keeping always near the Sun is never seen longer than an hour and 50 minutes, *before* the rising or *after* the setting Sun. Sometimes Mercury may be seen crossing the Sun, at which times he appears like a small black spot, describing a chord along the disk of the Sun, which demonstrates the Planet to be an opaque body, and that it borrows its light from that Luminary. Mercury is not much larger than the Moon, and when viewed through a telescope exhibits similar phases or changes, being sometimes horned, sometimes gibbous, and sometimes nearly full, but not entirely, because its enlightened side is never directly turned towards us. In general the laws of the movements of Mercury are complicated, he does not move exactly in the plane of the Ecliptic; deviating from it at times more than 5 degrees: we can discover no spots on the face of Mercury, consequently we have no means of computing the time of his diurnal motion, nor have as yet any Satellites or Moons been discovered to attend him.[1]

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[1] Those planets moving beyond the orbit of the Earth, are called Superior Planets.

VENUS.

Blend'st thou not with the twilight hymn,
Fair Orb of night?
Shed'st thou not through the vapors dim
A holy light?
Com'st thou not in the morning's dew
With sparkling eye?
While the blithe young lark is warbling throug
The blushing sky?

Peace to the heart that loves at morn
Beneath thy ray,
From earth and human gaze withdrawn,
To kneel and pray:
Peace to the breast that loves to raise
At gentle even,
Amid thy soft and tranquil blaze
Its thoughts to heaven.

CHAPTER VI.

The next planet is Venus, which is decide
the most beautiful star in the heavens: sh
with us called the morning and evening star,
always attends the Sun, giving forth her li
after he has set in the evening, and heralding
approach in the morning. Venus presents to
when viewed through a telescope, the same p
ses with the planet Mercury; sometimes we
her nearly round, at which time she is in t
part of her orbit which lies beyond the S
when nearer to the east or west, she appe
like the Moon in the different stages of incre
or decrease; when at her greatest distance fr
the Sun, she is like the Moon in her first q
ter; sometimes she is entirely hidden in the

's, at which time her whole unilluminated part ing turned towards us, she is consequently risible. When the air is clear, by the aid of good telescope, the surface of Venus appears versified with spots like the Moon, by the mo- n of which we discover the time she takes in volving upon her axis, which is observed to in 23 of our days. Her axis being very con- lerably inclined to her orbit, the variation of r seasons must be very great; and the length her days and nights differ very much in pro- rtion to each other. Venus is computed to 68 millions of miles from the Sun, and to ove in her orbit 76 thousand miles in an hour, mpleting her annual revolution in 224 of our ys: her diameter is 7648 miles. Twice in the urse of 120 years Venus passes over the disk the Sun; and in the year 1761 Captain Cook, ded by several astronomers, visited the south a to observe the transit.

THE EARTH.

Is there an orb in all the space,
More favored or more blessed than this?
Where glorious love and boundless grace
Makes e'en its sorrows pass a bliss!

Where day by day the gospel spreads,
From shore to shore in splendor bright;
And the Eternal Spirit sheds,
Upon the heart His holy light!

Where an all righteous Father gave,
His well beloved Son from high;
To call the sinner, and to save
Him from eternal misery.

CHAPTER VII.

The next planet in succession is our Earth, which like the other planets is spherical, but not an exact sphere; the diameter at the equator measuring 37 miles longer than that from pole to pole, consequently its proper figure is what is termed an oblate spheriod: its distance from the Sun is 97 millions of miles; its circumference is 25 thousand miles: it travels in its orbit to which its poles are inclined 66 degrees and a half, at the rate of 58 thousand miles an hour; and completes its revolution round the Sun in 365 days, 5 hours, 48 minutes, and 49 seconds; during which time, the Moon, which is its only satellite, performs 12 lunations. For a more particular account of the Earth, its divisions, climates, population, and produce, we refer the reader to the article Geography, in part the 2nd. of this work, and for a sketch of the history of of its inhabitants, to the Article Chronology.

THE MOON.

When the fair Moon breathes forth her tender ray,
Amid the sacred stillness of the night,
She hath a charm would lure the heart away,
From dark desires, to feelings new and bright;
And the pure flood of soft and plaintive light,
In which the night bird chaunts a touching lay,
Yields to the soul a sweet subduing balm,
Or bathes the heart in tears and makes it calm.

Sweet is thy presence o'er the bubbling brook,
On which a diamond brilliance thou dost throw;
Sweet is thy passionless and stedfast look,
When rising 'bove the mountains calm and slow;
And sweet thy aspect glancing thro' the nook,
Of some rude grot where chrystal waters flow;
Sweet is thy ray within some desert cave,
And sweet thy crescent beam upon the wave.

But sweeter far in innocence to bend,
Before the glorious Deity in prayer;
And feel a ray of light divine extend
Through the warmed breast to whisper he is there;
And sweeter yet to know that he will blend
His spirit ever with all those who wear
His likeness in their hearts; and sweeter still,
To know he will reward the doers of his will.

CHAPTER VIII.

The Moon. Her Phases. Revolution about the Earth. Her Orbit. Distance. Libration. Telescopic appearances. Volcanoes, &c.

Next to the Sun the Moon is the most remarkable of the heavenly bodies, being more conspicuous and exhibiting more striking changes, as well as quicker motions than any of them. Sometimes we see her with a full face, bright in every part, sometimes with her western side only bright, and again we see her perhaps during the day time like a cloud, with her western part ragged, as if eaten away; and after a little we have lost her altogether, till at the return of a certain period she again makes her appearance. These changes constitute some of the *most striking* phenomena in the heavens, *and the cause* that produces them is the rotatory

motion of the Moon about our Earth. When the Moon is due south at midnight, her disk is an entire circle, which is what is called a full Moon; the Earth at this period is midway between her and the Sun: on the next night she comes later to the meridian by about 48 minutes, and her disk on the western side seems to be wasted; on the next night, and on every succeeding night, that part of her suffers a greater decrease, until her disk, which seven days before seemed a perfect circle of brightness, now exhibits but a semicircle to the eye, at which time she is said to be in her quadrature. During another seven days this *semicircle* decreases gradually, till at last, after coming later and later to the meridian, it disappears altogether. After three or four days she again appears to the eastward of the Sun, soon after sunset, in the appearance of a fine bright crescent, with the convexity turned towards the west; this bright part increases now nightly as before it decreased, till it becomes a perfect circular disk, at which time it begins to decrease again till entirely lost, as in the former way described.

The time the Moon takes in going through these changes, is 29½ days, during which time she appears to advance among the fixed stars, at the rate of 13 degrees, 10½ minutes, on the average, in 24 hours. The appearances we have been describing are termed the phases of the Moon, and may be all explained on the supposition that the Moon is an opaque spherical body, *which moves* in a circular or elliptical orbit *round the earth*, while it receives its light from *the Sun*.

The Moon when *full* is opposite to the Sun; that is, the Earth is situated between the Sun and Moon; when she disappears, that is just before the new Moon makes her appearance, she is in conjunction with the Sun; in other words she is situated between the Sun and the Earth: of course her illuminated side is towards the Sun, and her dark side towards the Earth.

The Moon moves in her orbit from the west to east, and it is ascertained that she makes a complete revolution in the heavens in 27 days, 7 hours, 43 minutes, 5 seconds, which compass of time is called a periodical month; but her period from one conjunction to another, that is from new moon to new moon, or from full moon to full moon, takes up 29 days, 12 hours, 44 minutes, 3 seconds, which space is called a synodical month, or a lunation. This difference is occasioned by the Earth advancing in its orbit round the Sun, at the same time the Moon is moving round her; for during the time the Moon finishes her course, the Earth, and as before said, the Moon with it, has advanced nearly a whole sign in the ecliptic towards the east; so that the point of the Moon's orbit which in the former position was placed in a right line, joining the centres of the Earth and Sun, is more westerly than the Sun; therefore when the Moon has again arrived at that point, it will not yet be seen in conjunction with the Sun.

The orbit of the Moon is not in the same plane with the orbit of the Earth; that is like all the other *planets*, it is not in the ecliptic, but *inclined thereto in* an angle of about 5½ degrees.

These two planes, therefore, cut each other in two points, which points are called the nodes; and it is only when the Moon is in one of these nodes that the Moon is seen in the ecliptic; at other times she is either to the north or south of the ecliptic. The Moon's orbit does not constantly intersect the ecliptic in the same place, but at a point further westward every lunation, which repeated for 18 years and 223 days, brings her to cross the ecliptic in the same spot as at the beginning of that period. The points where the Moon crosses the ecliptic are called the nodes; and a line from the centre of the Earth joining the two nodes, is called the line of the nodes: from the retrogation of these nodes, the Moon's motion in her orbit, and the inclination of that orbit to the ecliptic, are produced the various eclipses of the Sun and Moon; for an account and explanation of which we refer our readers to page 68.

The mean distance of the Moon from the Earth is 236,267 miles. Her diameter is about 2,161 miles, and her rotation upon her axis is performed in exactly the same space of time she takes in moving round the Earth; consequently she always presents the same face to us, while the other half is never seen by the inhabitants of the Earth.

Those who observe the Moon attentively through a telescope, will also remark, that although the Moon's surface appears always the same to the naked eye, yet some slight peculiarities attend telescopic vision. One very small part or portion of her face on the eastern side

will be sometimes carried entirely out of sight, while a similar part on the western side will be brought forward. In another part of her revolution the contrary will be seen; the portion so brought forward on the western side will disappear, and the eastern portion will be brought into view. This irregularity is called the Moon's libration in longitude. Another sort of libration called the libration in latitude, arises from the axis of the Moon being inclined to the plane of her orbit, for sometimes in like manner we see more or less of her polar regions, in different parts of her revolution, as her poles are inclined more or less towards the Earth.[5]

When we look at the Moon with the naked eye, we perceive on her disk many duskish spots; through a telescope their number is infinitely varied, and prodigiously increased: they are found to extend themselves over her whole surface; she also appears to be much more protuberent in the middle than at the edges, and in

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[5] Harvest Moon.—It is generally believed that the Moon rises about 50 minutes later every day than on the preceding, but this is true only with regard to places on the equator; in places of considerable latitude there is a remarkable difference, which is noticed in harvest, when the full moon continues to rise very soon after sunset for several evenings together. On the other side of the equator the people have their harvest moon as well as we; but their seasons being contrary to ours, the order of them is consequently reversed: from this wise arrangement of the Creator, those who live at the poles, *and who have six months* night at a time, have the benefit *of the moonlight* in a far greater degree, as she shines *here without setting* every second fortnight.

fact to have the figure of a globe, and not th
of a flat circle, as she appears to the eye, wh
unaided by that invaluable instrument.

That the Moon has prodigious inequalities
her surface, such as mountains, hills, vallie
and caverns, is proved from the appearance
her edges; for instead of their seeming perfect
smooth when looked at through a telescope, th
are noticed to be toothed and cut with innume
able notches and breaks, and at the same tim
in those parts which appear dark, there may
perceived, at 3 or 4 days after a new moon, l
tle shining points, doubtless the tops of h
higher mountains, which necessarily receive t
Sun's light before the lower parts; these shini
points increase as the Sun shines more and mo
on that part of her disk, till they exhibit no da
portions about them. These bright portions a
also observed always to cast a sensible shad
upon that part of the Moon's surface furthe
from the Sun's rays, and these shadows are n
ticed to become shorter as the Sun shines mo
directly upon her face, when she approaches t
full: this is the natural effects of sunshine up
our Earth, and it is impossible to believe t
that these appearances are produced from sir
lar causes.

From these appearances astronomers ha
been enabled to calculate the actual height of
mountains in the Moon, which form extens
chains; among which some are found to
more than 1 mile high;[6] it has been also asc

[6] *Dr. Herschell,* who possessed the best tele

hat volcanic eruptions exist in various
the Moon's surface, similar in appear-
d effect to the burning mountains of
Etna, and Vesuvius, upon our globe;
ng the extensive chains of mountains
pread themselves over various parts of
n's surface, many are found to contain
and to be in fact volcanoes throwing
. The appearance they make in a state
ion, when viewed through a telescope,
g to Dr. Herschel, is that of a small
burning charcoal, when it is covered by
hin coat of white ashes, having a degree
ness about as strong as that with which
oal would be seen to glow in faint day-
nd these are observed to cast a visible
n the adjacent mountains.

seems then but little to be wanting in
complete the analogy between the
nd our Earth, except inhabitants; it is
perceive no large seas in the Moon, and
aware that her atmosphere is extremely
d perhaps unfit for the purposes of ani-
; but we also know, that if we only
flower in the field, we find it, by the aid
nicroscope, full of living creatures, to
is a world, supplying them with all the
s for their brief existence: we cannot
a moment suppose that the economy of

---

nted, from numerous observations made upon
tains in the Moon, concludes that none of the
(excepting one situated near Lucus Niger)
an half a mile in height.

nature, by which we always mean the Author of Nature, would extend itself so minutely in this instance, and leave so large a body as that of the Moon without beings having organs adapted to the peculiarities of their situation.

Such are the principal phenomena which distinguish the Moon; but we ought not to pass over the great benefits which she affords the Earth. The light she gives us at night, and the quiet sanctity she throws over the face of nature, we ought continually to feel grateful for; as we ought also for her attractive influence which sways the ocean. We see in her, as in all other bright emanations from the Divine hand of the Almighty, a manifestation of his goodness, an instance of his wisdom, and a continued exemplification of his love.

MARS.

With a burning brow and a bloodshot eye,
Fiery Mars essays to shine,
And looks like a king in the eastern sky,
Or a victor flushed with wine.

I have seen him rise with a warlike charm,
O'er the ocean's tranquil flood;
'Till his deep'ning ray, like a soldier's arm,
Had tinged each wave with blood.

They say that thy looks are from mist and cloud,
That round thy aspect roll;
'Tis thus that the passions of life enshroud
The brightness of the soul.

CHAPTER IX.

Mars comes next in order to the Earth, and is distinguished in the heavens from the rest of the planets by the redness of his colour, which is attributed to the density of his atmosphere. His figure has been proved to be that of an oblate spheriod like that of the Earth. He performs a revolution about the Sun at a distance of 144 millions of miles from the body of that luminary, in about 687 of our days; and moves round his own axis, which is inclined to the plane of the ecliptic 59 degrees, 41 min. 49 sec. in 24 hours, 39 minutes, a fact ascertained by an immensely large spot seen on his body: this spot, with others, were first observed by Cassini, at Bolonga. Beside these, a remarkable brightness exists about the north and south pole of this planet; this is supposed to arise from the snow and ice accumulated about those parts, as it is in our planet, as they are observed to grow less when turning from the Sun, after enjoying their summer season, and are largest when turning out of their 12 months winter. In many respects Mars is nearest in resemblance to our planet of any in the solar system.[7]

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[7] The orbit of Mars is inclined to the plane of the ecliptic 1 degree, 51 minutes, 3 seconds, whence it is calculated that the days and nights are of an equal length on every part of her surface. This inclination of the orbit *to the ecliptic* experiences a diminution of 1 second *four thirds in a century.*

JUPITER.

Still as we cast our looks on high,
New glory meets the upturned eye;
Fresh worlds of happiness and bliss,
Enlightened and beloved like this;
Throw out a high intelligence
Upon the more exalted sense:
Our souls seem lifted as they gaze,
From their corrupt unholy ways,
Towards the bright and glittering dome,
As to their everlasting home;
And fain would blend with all that's fair
And beautiful and holy there.
A breathless calm, a quietude,
Where human wrong cannot intrude;
Comes from those star-gem'd heights, revealing
Fresh stores of bliss and purer feeling;
And as in harmony they roll,
Throw forth such magic o'er the soul;
That it might deem the night were given
To hold communion with heaven:
Taught thus it bends before thy throne,
Thou great and good Eternal One!

CHAPTER X.

Jupiter, excepting Venus, is the brightest of all the planets; he moves in his orbit at the rate of 29 thousand miles in an hour; he is also computed to be 91 thousand miles indiameter, being nearly a thousand times larger than our *Earth; his* distance from the Sun is five times *greater than* that of our planet, it being 494 mil-

planet turning so swiftly upon its axis, its figure is much more oblate than that of any planet in the system, he being more than six thousand miles at his equatorial than at his polar diameter. The same circumstance also occasions the clouds to collect in streaks about the equatorial parts, which are called by astronomers Jupiter's belts, having, when viewed through a telescope, the appearance of belts round his body. These belts or streaks, which were discovered by Fontana, are always seen in an horizontal position, and generally parallelled to each other; their breadth is not always the same, one being often seen to grow narrow, while another in its neighbourhood has been observed to widen considerably. In addition to these belts, Hooke discovered spots of various size and shape upon the body of Jupiter: the largest, which was observed by Cassini, in 1665, appeared round, and moved with the greatest velocity when in the middle of the planet, but slower as it reached his circumference, similar to the spots upon the Sun. By further observations made upon this principal or ancient spot, (as it is called), the periodical rotation of Jupiter upon his axis was determined, which is 9 hours, 55 minutes, 49 seconds; his rotation is from west to east, like that of the Sun; and as his axis is very nearly perpendicular to the plane of the ecliptic, he can experience very little from the variations of the seasons.

Jupiter is attended by four moons or satellites, which are all supposed to move in ellipsesses, and their orbits are but little out of the same

plane. The first of these satellites revolves round the body of the planet, in one day 18 hours, the second in three days 13 hours, the third in seven days three hours, the fourth in 16 days 16 hours.[8] These satellites are continually suffering eclipses, by passing behind the body of the planet, and as these observations are discoverable from our earth, and are seen at the same instant of time, from what ever part of the world the observer may be placed; they therefore afford mariners the best means of ascertaining the longitude. To find the longitude by the immersions of Jupiter's satellites, it is necessary to look in the English Ephemeris, where all the eclipses of Jupiter's first satellite, both the immersions and emersions are calculated according to the meridian of London; if then by a good telescope and correct chronometer, we attend to the emersions of the satellite, according to our distance east or west from the meridian of Lon-

[8] Sometimes the satellites pass before the body of the planet, over his disk, being interposed between the Earth and their own planet: when the satellites pass behind Jupiter, the circumstance is called an occultation; when before him, a transit: but it is not often that a satellite can be discovered upon the disk of Jupiter; it is, however, remarkable, that the satellites have been observed to pass over the disk of Jupiter, in the appearance both of a lucid point brighter than the planet himself, and of a dark spot. It was by observing these eclipses of Jupiter, that it was discovered that light is not *propagated instantaneously*, though it moves with extreme *velocity*. A ray of light is found to travel from the Sun *to the Earth in* about eight minutes of time, thus moving *at the rate of 200,000* miles per second.

lon, so will the hour of its appearance differ from hat of the calculation: now as 15 degrees of notion under the equator, answers to one hour f time, so by the difference of time we measure he difference of distance, which gives us the *ongitude*, or in other words tells us exactly how ar we are east or west from the meridian of London.

SATURN.

Is there a ray, is there a flower,
Of beauty, or of brightness given,
That hath not some subduing power,
Some influence o'er the lonely hour,
To lift the soul to heaven?

The gleam that meets the ardent gaze,
Lights up the heart to gratitude;
The Sun's bright glare, the Moon's soft rays,
The Stars in their triumphant blaze,
Blend holy thoughts with solitude:

And this far orb of light intense,
Rolled he alone amid the skies;
Would throw a flashing eloquence
Upon the spirits finer sense,
And bid its raptures rise.

'Tis even thus, where'er we turn,
Eternal love and joy we see;
Then may not, Lord, man's spirit learn,
From thy all perfect works to burn,
With love as pure for Thee?

CHAPTER XI.

Saturn is the sixth planet in the order of o
system, and is not quite so bright as Jupiter, b
when viewed through a good telescope makes
more remarkable appearance than any of t
planets. Galileo first discovered his remarkab
shape, which appeared like two small glob
joined, one on each side, to a very large on
having viewed him for two years, he was su
prized to find him at last quite round like a
other planet; but in the course of time, he r
sumed his original appearance. About 40 yea
after Galileo, Huygens by the aid of a tel
scope, magnifying 100 times, discovered th
this appearance was owing to a broad thin ri
surrounding the planet. This ring is detach
from the body of Saturn, in such a manner, th
the distance between the innermost part of t
ring, and its body, is equal to its breadth; bo
the outward and inward rim of which is pr
jected into an ellipsis, more or less oblong a
cording to the different degrees of obliquity wi
which it is viewed; the reason of the disappea
ance of the ring to Galileo, was because his e
had got upon the plane or edge of it, and it b
came invisible; not being as is supposed fitt
to receive the Sun's light, or more probably b
cause it is too thin to be seen at such a distan
The ring was invisible to us in the year 181
but has since that time been gradually increasi
in light and breadth, presenting a beauti
object for the telescope: in 1833 the ring
be again advancing to us and invisible.

copes of great magnifying power, two belts
ripes have been discerned on Saturn; they
ar parallel to the ring, and are supposed to
ermanent. Dr. Herschel has demonstrated
this ring has a rotation round its axis, and
as observed, that the ring casts a strong
ow upon the planet, inferring from thence
the substance of the ring, is no less solid
that of Saturn himself.[9] Various hypo-
s have been assumed concerning the nature
is remarkable particular appertaining to
rn: some have imagined the diameter of
lanet, once to have been equal to the outer
mference of the ring, the present body being
ined within the former surface, like a nut
shell, and that from some unknown cause,
uter shell fell down to the inner surface:
thing that can possibly be said upon such
ject however, must be perfectly conjectural.
rn is computed to be upwards of 900 mil-
of miles distant from the Sun, and is
ed round him in 29½ of our years, at the

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cording to the opinion of La Place, and of most
n astronomers, the ring of Saturn is composed of
oncentric rings; the interval between the two is
3931 miles. Their dimensions, according to Hers-
are as follow:

The larger Ring,

diameter, 204,883 miles; inner diameter, 190,248
; breadth, 19,024 miles.

The smaller Ring,

diameter, 184,393 miles; inner diameter, 146,345
breadth, 7,931.

both revolve round Saturn in 10 hours, 29 mi.
nd 16 seconds,

rate of 22 thousand miles an hour. His diameter is 77,680 miles, which is about 966 times larger than the Earth, his rotation on his axis is very rapid, being according to Herschel performed in 10¼ hours. The orbit of Saturn is inclined 2 degrees 29 minutes 35 seconds to the plane of the ecliptic. Saturn is also remarkable for the quantity of moons that attend him; they are seven in number, the first at the distance of 72,097 semi-diameters of his rim, and 4,893 of the planet himself, performs its revolution in 1 day 21 hours 18 minutes 57 seconds: the second at 2,686 semi-diameters of the ring and at 6,268 of Saturn, revolves in 2 days 17 hours 41 minutes 22 seconds: the third at the distance of 8,754 semi-diameters of Saturn, and 3,752 of the ring, revolves in 4 days 12 hours 25 minutes 12 seconds: the fourth, called the Huygenian satellite at 8,698 semi-diameters of the ring, and to 295 of Saturn, revolves in 15 days 22 hours 41 minutes 12 seconds: while the fifth placed at 69,514 semi-diameters of Saturn, and 25,348 of his ring, does not perform its revolution in less than 79 days 7 hours 47 minutes: the sixth and seventh satellites are of later discovery than the other five, and are nearer to Saturn's body: Dr. Herschel observed the fifth satellite to turn round its axis, exactly in the time in which it revolves round Saturn.

HERSCHEL.

Still onwards soars the soul, far, far, from earth,
To the remotest orb that decks the sky,
And onwards still; for this is but the verge,
The mere frontiers of his immensity.
How grand will be the scene? how glorious
The view unlimited, the stretch sublime
Of these poor eyes, when they shall have put on
Their immortality: worms may destroy
This body, and the dark, dark, grave may close
Upon us with her flinty jaws,—but oh!
She cannot shut us from the presence of
The Deity; we shall behold him yet,
In all his glory and perfections; full
Of harmony and beauty, full of love,
And full of truth: These are the shadows only
Of the Eternal; atoms loosely flung
Through the immensity of boundless space,
All perishable; creatures of an hour:
Only the soul comes near *His* essence: That
Alone survives the universal wreck;
And that *alone* is privileged, to look
And live, upon its God. Rejoice then, man,
Rejoice through all thy powers: Rejoice through all
The glorious works of nature: Still rejoice
In Him, through all the stages of the day,
And through the star-lit watches of the night,
And 'neath the shaft of sullen death,—Rejoice!
Rejoice!! Rejoice!!!

CHAPTER XII.

The Georgium Sidus, called also Herschel, *is, as far as has* yet been discovered, the outer-*most body of* the Solar System; and would

never have been discovered but for the invention and the great modern improvements of telescopes; for, although "Herschel" was observed by Flamstead and others, it was not thought to be any thing more than a very distant star. Dr. Herschel, however, in the year 1781, noticing it near the foot of Castor, by the aid of his telescope of the highest magnifying power, soon ascertained it to be a planet. It is twice as far distant from the Sun as Saturn, or 1822 millions of miles; and its greatest distance from the earth is about 1727 millions of miles. its diameter is not so great as that of Saturn being but 34,457 miles; its periodical revolution is made in 83 years 294 hours 39 minutes and its hourly motion in its orbit, which is inclined to the plane of the ecliptic, 46 minutes 2 seconds, is 15,846 miles. The Herschel is attended by six satellites, whose motion is retrograde, and contrary to the order of the signs in the Zodiac: the most distant of them is supposed to revolve round the planet in about 10 days 16 hours, 40 minutes. Herschel, when seen with the naked eye, appears as a fixed star of the sixth magnitude, with a bluish white light and of a brilliancy between that of Venus and the moon.

NEW PLANETS.

CHAPTER XIII.

Ceres. Pallas. Juno and Vesta.

om the great space which exists between bits of Mars and Jupiter, it had often been sed that some planetary bodies were situ- herein; and the discovery of these, by the f the telescope, has verified the supposi- The same have been denominated aste- by Dr. Herschel: they are situated nearly equal distance from the Sun. and are sup- by some astronomers to be the fragments lanetary body, shattered to pieces in con- nce of a violent concussion with some t.

CERES.

res, when viewed through a good telescope, rs of a ruddy colour, and looks like a star eighth magnitude; it performs its revolu- about the Sun, in 4 years, 7 months, and ys; at a distance of 260 millions of miles. Herschel makes the diameter of Ceres to ly 160 miles, but Schroeter makes it ten *as large, and* gives it an atmosphere 675 *in height,* to which he attributes its dull *avy light.* The inclination of its orbit, to

the plane of the ecliptic, is an angle
than 10 degrees. Ceres was discove
M. Piazzi, on the 1st. of January, 1800.

PALLAS.

This planet is nearly the same ma
with Ceres, and it is remarkable for t
inclination of its orbit to the plane of th
tic; which makes an angle with it of n
degrees. The mean distance of Pall
the Sun, is 266 millions of miles; being
millions of miles from Ceres; consequen
length of its year, which depends upon
tance from the Sun, is not much great
that of her's. The Pallas was discov
Dr. Olbers, of Bremen, in 1802, and its
ter is not thought to be more than 80
although Schroeter, with perhaps greater
bility, thinks it to be 2099.

JUNO.

Juno is nearer to the Sun than any
above planets, and was discovered
Harding, of Lilienthal, in Germany, i
She appears of a reddish colour, but S
has observed a very remarkable variatio
brilliance; which he thinks is owing t
variations going on in her atmospher
mean distance of Juno from the Sun
millions of miles; and its annual rev

made in 4 years 128 days of our time. The inclination of its orbit is 21 degrees, and its diurnal revolution about its axis, is made in 27 hours. The real diameter of Ceres is thought by Schroeter to be 1425 miles.

VESTA.

The last planet that has been discovered is Vesta, and is nearer to the Sun than the other three. Seen by the naked eye, it appears like a Star of the 5th or 6th magnitude, giving out a pure white and intense kind of light. Vesta had been often seen before, but by observation made by Dr. Olbers in 1807, it was ascertained to be a planet, situated within the orbit of Juno and Mars. Its year is about the length of 3 years and 66 days of our time. The diameter of Vesta has not been very accurately ascertained; it is thought, however, to be about 1800 miles: it is distant from the Sun 225,435,000 miles, and the inclination of its orbit to the ecliptic is 7 degrees, 8 minutes, and 46 seconds.

We have thus given as particular an account of the planets as the limits of our work would permit us; and in contemplating the grandeur of their arrangement, the harmony of the whole, and the beauty which pervades this portion of the Creator's *works*; let us not at the same *time forget the* words of the inspired psalmist, *that* .....

" OUT OF ZION HATH GOD APPE
IN PERFECT BEAUTY."

Out of Zion thy beauty,
From mercy's pure throne,
To the Earth in its dimness
All perfect hath shone;
And ages of darkness
Could never beguile,
The Earth from thy presence,
Or man from thy smile.

Oh! the orbs that are glowing
In brilliance on high,
And the stars nightly throwing
Their light from the sky;
Or the Sun in his splendor,
And beauty divine,
Hath not such a glory
As the heart feels in thine!

Nor the dew drop when bearing
The tints of the dawn;
And the icicle wearing
The light of the morn:
How lovely soever
Their beauty may be,
To the heart they can never
Throw beauty like thee!

When that heart seeks to praise th
For all thou hast given;
And melts into love,
With the mild ray of even:
Or when in night's silence
It beats high with prayer—
Oh do not thy glory

When we feel thy commandments,
All holy and just;
And we kneel at thy altar—
Our hearts in the dust;
Oh is there not springing
A flowret most fair,
To tell that thy glory
And beauty is there?

When that high world revealeth
A foretaste of bliss;
And the pure spirit sealeth
Its heaven in this;
In those thoughts, in that longing
For freedom's pure air—
Oh do not thy glory
And beauty live there?

The tears of our sorrow
Have a charm as they flow;
Like the rain drops that borrow
The Sun's golden glow;
And shew in the darkness
Of gloom and despair,
That goodness, and glory,
And beauty is there!

COMETS.

Ye stranger orbs!
Who wander ever through the blue abyss:
Feed ye the Sun with fresh material fires;
Or are ye dread and fatal ministers
Of the Eternal's wrath, to sinful worlds?
Ye are His workmanship at least! and He
Guides ye from sun to sun through all the host
Marshalled upon the starry plain: and thus
Ye are a beauty, and a mystery; and fill
The panting mind with high desires, and make
Us long to put on immortality, and soar
Above the fathomless infinity
In which ye range: But He who threw ye forth
Upon your orbits, and sustains you still,
Sustains the spirit in its loftiest flight;
And makes vague hope a very certainty,
And high anticipation as a joy
Already ours.

CHAPTER XIV.

Comets, their appearance. Conjectures of the Ancients. Isaac Newton's Observations on the Comet of 1680. Hal Calculations. Whitstone's Opinions.

In addition to the planets already describ there are other moving bodies seen in the h vens; which make their appearance sudden and after having continued with us for a sh *time, appear* lost in the immensity of space; th *are called* Comets, and about 500 of them *been seen* at various times. They are of va

sizes, and of different appearances, some carrying a long stream of light, which is called the tail, and which is noticed to be always opposite the Sun; others are surrounded with only a bright rim or beard. Comets seem to shine by the light of the Sun, and are supposed to be encompassed by an atmosphere of apparently fine matter, resembling that of the Aurora Borealis; this is called the head of the Comet, and the internal part, the Nucleus. When a Comet arrives within a certain distance of the Sun, an exhalation issues from it; this is called its tail, and is always directed to that part of the heavens opposite to the Sun, and increases in dimension and brightness as it approaches that luminary.

Of all the heavenly bodies, Comets have given rise to the greatest number of conjectures and speculations. The vulgar and ignorant in all ages, have foolishly considered them the forerunners of disaster, calamity, and war. In the early ages Pythagoras, as he had of the solar system a just conception, also came nearer to the present opinions upon Comets, than any of the ancient philosophers. Aristotle supposed them to be nothing but meteors casually lighted in the air; it is true that a prediction was made by Seneca, in the reign of Augustus Cæsar, that the time would arrive, when the nature of Comets, their magnitudes, and the laws by which they are governed should be known, and their motions explained; succeeding improvements in *science, have enabled* us literally to fulfil this

remarkable prediction.[1] Sir Isaac Newton in his observations on the great Comet of 1680, determined them to be planets, but moving in very eccentric ellipses. In support of this doctrine, Dr. Halley calculated the periods of the return of 24 of them; by his computations, the Comet of 1682, was the same which appeared in 1607, and 1531, and consequently has a period of about 75 years; and he foretold its return about the year 1758. Since the time of Dr. Halley, other astronomers have calculated the elements of 25 more of these wandering bodies, and inferred from the difference of their motions and appearance, their number to be very great. It is now generally agreed that Comets are opaque bodies, enlightened by the Sun, as they are observed to show different phases like our Moon. Whitstone attributes the general deluge in the time of Noah, to have been produced by the Almighty, suffering the earth to pass through the atmosphere of a Comet, whose attraction raised a great tide of the subterraneous waters; so that the outer crust of the earth was changed from a spherical, to an oval or egg-like figure; and as this could not be done

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[1] Seneca in like manner predicted the discovery of America, for a passage in one of his works is as follows:

——— "Venient annis
Sæcula seris, quibus oceanus
Vincula rerum laxet, et ingens
Pateat tellus, Tiphysque novos
Detegat orbes: nec sit terris
Ultima Thule."

without making fissures or cracks in it, he concludes the water to have forced itself through them; in consequence of the figure of the earth being changed into a less capacious shape, and thus "the fountains of the deep were broken up." The intense darkness which is known from scriptural authority, to have covered the earth at the time of the plagues of Egypt, and at the time of our Saviour's crucifixion; is accounted for, by supposing the Almighty to have used them for the instruments of his will, and suffered one to come between the Sun and the Earth, which must cause a darkness much more intense, and of much greater duration than could possibly take place in any eclipse produced by the Moon. A Comet, it is also thought, will be the instrumental cause of that great catastrophe, the general conflagration at the last day, foretold in the Sacred Writings; in which the earth shall pass away with a great noise, and the elements shall melt with fervent heat: "Seeing then that all these things shall be dissolved, what manner of persons ought ye to be, in all holy conversation and godliness, looking for and hastening unto the coming of the day of God: nevertheless we, according to his promise, look for a new heaven, and a new earth, wherein dwelleth righteousness."

The greatest distance of the Comet of 1680 from the Sun, was about 11,200,000,000,000 miles; the period of this Comet is 575 years.

ECLIPSES.

When shade and darkness shroud the bloom,
Of nature from the human sight;
And day takes up the sullen gloom,
That wraps the starless brow of night:
Awake, Oh soul!—put on the ray
That turns that deepest shade to day;—
That *gloom* to *glory!* Walk awhile
With *Him* who sheds a brighter smile
Than daylight's proudest beam e'er throws,
Amid the fragrance of the rose:—
Let the day faint in darkness; be
The light extinguished in each sphere;
Darkness cannot envelope Thee,
While *He*, thy LORD and GOD is near.

The darkest hour the bosom knows,
And all its griefs, and all its woes,
In evil and in sin:
Extinguish not the warning flame,
That burns from age to age the same,
The light he sheds within.

The deepest gloom that ever shed,
Above the living and the dead,
A deep and dark control;
Could never yet destroy that light,
Nor yet *eclipse* the visions bright
It flings around the soul!

CHAPTER XV.

Cause of Eclipses. Eclipses of the Sun and Mo

The Satellites of the different planets, *many of the* stars suffer eclipses, or rather *cultations; but* the eclipses of the Sun and

are the most striking. They were formerly considered by the ignorant, as indications of the displeasure of heaven, and excited the greatest consternation. Science, however, has revealed to the wise of the early ages, and to the present generation, that they depend upon regular and invariable causes, and may be calculated and foretold with the greatest certainty.

As the Earth is an opaque body, enlightened only by the Sun, it must cast a shadow towards that side which is furthest from the Sun. If the Sun and Earth were of the same size, this shadow would be cylindrical, and would extend to an infinite distance; but as the Sun is much larger than the Earth, the shadow of the latter must be conical, ending in a point. On the sides of this conical shadow, there is a diverging shadow, the density of which decreases in proportion, as it recedes from the sides of the former conical shadow; this is called the Penumbra. As the Moon revolves round the Earth, sufficiently near to pass through the shadow of the Earth, an eclipse must always take place; when the Earth, the moon, and the Sun, are all in one straight line. An Eclipse of the Moon can never happen but at the time of full moon; but on account of the inclination of the Moon's orbit to that of the Earth, an eclipse does not take place every full moon. When the Moon passes entirely through the Earth's shadow, the eclipse is total; but when only a part of it passes through the shadow, *the eclipse is* partial. The quantity of the *Moon's disk* which is eclipsed (and the same

thing is to be understood of that of the Sun, in a solar eclipse) is expressed in the number of digits, that is, the disk is supposed to be divided into 12 equi-distant parallel lines; then if half the disk is eclipsed, the quantity of the eclipse is said to be six digits.

The Eclipses of the Sun are owing to a different cause to those of the Moon. They are occasioned by the Moon coming directly between us and the Sun, and therefore obstructing our view of it. When the Moon happens to be in conjunction with the Sun, or between the Sun and the Earth, viz. at the time of the new moon, the shadow of the Moon falls upon the surface of the Earth, hence, properly speaking, such eclipses should be called eclipses of the Earth. But the whole disk of the Earth cannot be involved in the shadow of the Moon, because the Moon is much smaller than the Earth; and besides the shadow of the Moon is conical. As the Moon is not always at the same distance from the Earth, it sometimes happens, that the conical dense shadow does not reach the Earth; and only the penumbral shadow falls upon it: the Eclipse consequently is partial to every part of the Earth: those who are at the centre of the penumbra will lose sight of the centre of the sun, by the interposition of the Moon's body, which subtending a smaller angle than the Sun, will not entirely cover its surface, so that there will be a ring of light: the Eclipse is then said to be *annular*.

Seven is the greatest number of Eclipses that *can happen* in the year, and two the least:

there be seven, five must be of the Sun, and two of the Moon: if there be only two, both must be of the Sun, for in every year there are at least two Eclipses of the Sun. There can never be more than three Eclipses of the Moon in the year, and in some years there are none.

When any of the planetary bodies disappear behind another or by the Moon's passing before it, the event is called an occultation. The Eclipse of Jupiter's Moons, as we have stated, are of great use in determining the longitude; the occultation of the fixed stars by the Moon, are made use of by mariners for the same purpose.

THE TIDES.

Oh glorious Ocean! where the thunders walk
In regal majesty from pole to pole,
Throwing their deep dun shadows o'er thy breast,
White with impassioned foam; and the high storm
Mingles melodious discord with thy full
And touching cadences: With rising awe
The soul surveys thy multitude of waves,
That seem to dance in an eternal joy,
Lifting their heads in extacy as they
Would kiss the very clouds.

ETERNAL GOD!
Whose spirit moved upon the mighty deep,
And called it from dark chaos into form;
And spread a deep blue sky above, and stored
Its depths with animation; and dost rule
With love divine its daily ebb and flow;

Thou send'st the tempest forth, with clo
Wrapped in turban'd grandeur round his
Astride upon the whirlwind's rage, that l
A wild steed plunges through the battlin
The phrensied lightnings quivering on th
As struck from hoofs of temper'd mail :
Thy ear is lent in mercy, when the wret
Doth writhe in drowning agony amid
The boiling billow ; and thine eye doth
In soft compassion at the speechless pray
When gurgling waters seal the lip in dea
For *He* who walked upon the wave, and
The howling storm subside—IS EVER NE

CHAPTER XVI.

Power of attraction, demonstrated by Newton.
tion of the Sun and Moon. Opinion of Sir Ric
Changes produced by the Ocean on the face
Poetical Illustration.

It is reported of the philosopher
that he threw himself into the Euripu
he could not find out the cause of t
reflux of the Sea ; this may possibly
tale, but we are nevertheless certai
ebbing and flowing of the Sea was
many of the things the ancients we
able to comprehend. Although Pliny
and Macrobius, supposed them in so
fluenced by the Sun and Moon.
shew this phenomenon of nature, to b
the Moon's influence upon the w
Newton demonstrated it to be a ne
sult of gravitation. It is easy to sup
although the attractive influence can
shape of the solid parts of the Globe

nevertheless produce certain effects upon the fluid parts. Thus then it is, the Ocean is drawn towards the Moon, and it is therefore high water at the place perpendicularly under the moon, or where the Moon crosses the meridian. If we fix a string to the side of a circular flexible hoop, and thereby swing it round in a circle, we readily conceive how the part next the hand would draw out or swell by the drawing of the string, and how the opposite part would fly or swell by the centrifugal force, it being least drawn in; and how the intervening parts of the hoop would become depressed and flattened. It is thus with the Ocean; that part of it which is immediately under the Moon, is raised by its attraction up into a swell; and that part which lies on the opposite side of the Earth, is thrown up into a similar swell by the motion of the Earth in its orbit by the centrifugal force.

The Sun, also, has some action on the waters, but only in the proportion of three to ten, in consequence of his great distance from the Earth, compared with that of of the Moon: sometimes it happens at the full and change of the Moon, that the Sun's attractive force is united with that of the Moon, and increases it; this union is productive of what are called spring tides; at other times during the half moons, the attractive power of the Sun and Moon counteract each other, and produce what are called neap tides.

The height of the tides at different places, depends in a great measure, upon the local situation of such places, and the varying depth of the Sea: shoals, narrow channels, &c., will o

casion a considerable difference in the height of the tide, at places under the same latitude. Thus the tide rises higher and faster in a narrow than in a broad channel; at the mouths of rivers the ebb tide continues longer, and high water is later than in the open ocean, because the currents of rivers oppose the return of the tide from the Sea. It is further observable, that at the poles of the Earth the diurnal tides do not exist, for the Moon never attains any considerable elevation above the horizon in those climates, and therefore the tides are scarcely perceptible.

This theory concerning the tides has been opposed by many, in common with that of gravitation; and Sir Richard Phillips supposes the tides to be caused by the two-fold motions of the Earth, and by the constant re-action of fixed land on moveable water, during the daily rotation of the whole terrestrial mass of fixed and fluid materials: but the account we have here given may be safely considered as firmly established, as it is supported by the opinions of the ablest men in every country; but if even there were wanting, the universe itself bears testimony to the opinions of NEWTON.

The constant recurrence of the flux and reflux of the Sea, through many ages, have, as may naturally be supposed, wrought considerable change upon the face of the globe; for many parts of it which were formerly several miles inland, are now entirely covered by the ocean; whilst others, that were once the sublime fastnesses of the monsters of the deep, are become

the habitations of man : thus we are compelled to witness a sad silent never ending mutability, impressing us with the idea of the unstability of all sublunary things.

——————————— There is within,
All that the Universe contains,—the Earth,
Her sons,—the Heavens and all their host;
A law of universal mutability;
A spirit of declension and decay,
Waging eternal war. Matter, might,
Breed the destroying worm. The strongest bend,
The iron bar corrodes, the gauntlet rusts,
The diadem and sceptre come to nought;
And all things 'neath the canopy of heaven,
The impress bear of change, that seems to say
That they shall have an end. Sweet nature hath
A face that smiles upon us: morning, noon,
Have each their fascinations; and the soft
And tender glance of evening, when the daylight
Sinks into rosy slumber in the west,
Hath sure a charm that reaches to the heart,
And human nature welcomes; yet we look
Upon the budding flowret with a sigh,
For it must fade; we cast our eyes above
To heaven's unfreckled azure, where the sun
Moves onward in sublime array of light,
And the innumerable multitudes
Of sparkling centres to surrounding worlds,
Exhilarate in ever boundless joy;
And would expatiate in joy as high,
But Death's dark shadow passes over us,
And Time's heart-chilling pinion fluttering by,
Strikes out the transient blaze that flashes from
The striving spirit, leaving the poor mind
Aghast in its imaginings, and dark
And cheerless as the grave: for all shall pass
Like *unreal phantoms* into nothingness;
The burning sun,—the stars,—the gaudy world,—
All, all, shall flee away!—And what is man,

That he should look on them? and what is life?
A breath, a sound,—whose sullen echo Death
Beats at the heart eternally: a mist,
A murky vapor of corrupting earth,
In which the spirit dances strangely, like
A fen fire wandering giddy and alone:
Yet not so lonely, Lord, when led by Thee;
For Thou, Eternal Father, it is *Thou*
Canst turn this gloom to glory;—It is *Thou*
That art the holy resting place, the ark
To which the dove-like spirit, wearied of
Terrestrial tumults, turns with heavenly hope:
Thy spirit mingles with man's spirit in
Its high desires, and holy aspirations,
And lifts it into extacy, though clogg'd
With mortal clay, and parch'd with the strange heat
Of life's incessant fevers.

Then to Him
Turn thou in glorious cheer, oh soul of man;
Be full of his pure brightness, full of hope,
And full of faith, and joy, and inward love:
Then may the battling elements rage on,
And wild convulsions rack the womb of earth,
And storm and tempest triumph, 'mid the shouts
Of their ten thousand thunders—Thou wilt be
Still CALM.

THE FIXED STARS.

Here is thy glorious temple, mighty Lord,
Here, 'neath the gorgeous concave of the sky
Ten thousand lustres glitter from that dome,
Innumerable multitudes of glowing worlds,
Unnumbered suns and systems, sparkling orbs,
And satellites of fire. Sink to the dust
Ye who stand vaunting in the ermined robe;
Throw down the sparkling diadem. Behold
The meanest attributes of HIM who reigns
O'er myriad myriads of exhaustless worlds;
King and Creator of them all. Oh Earth!
That thy poor sons, to day but sin and shame,
To-morrow but corruption, can be proud
Of a few sparkling gems, a little dross,
A little power to do unlawful deeds;
Look on the glowing firmament, ye vain
Of title, or of homage, or of state;
Look on yon sun,—then turn your eyes again
To the poor paltry pageantry of thrones,
And be not proud——but weep.

CHAPTER XVII.

Arrangement into Constellations. Appearance of New Stars. Stars supposed to be Suns. Of their Distances. Poetical Illustration. Conclusion of the Subject.

In considering the order of the spheres, we find a beauty, simplicity, and regularity, which give us exalted ideas of the Divine Being; and if there were no other celestial objects to contemplate, *beside* the ones we have considered, *we should still* have a high admiration of Hi

perfections: but upon casting our eyes up
vast and magnificent expanse of sky abo
we view such multitudes of heavenly l
that we become compelled, by a sense
wisdom, power, and benevolence, to fall
and worship at His throne. We feel that
are weak, that thoughts are vain, and th
prostration of our spirits, before HIS SPI
the first act we ought to perform. The s
the starry heavens at once humbles and
man feels, as he there contemplates, th
glorious attributes of the DEITY, his ov
mortality: and although put in comparis
the perfections of the Almighty, he may
mean; yet the capacity with which he i
to comprehend the works of creation, st
vates him to the sublimest heights within l
making lowly adoration the most exalted
cle of human bliss.

In attempting to examine the heaven
the shining bodies of which they are com
our attention in the present chapter is c
the fixed[2] stars, which we find apparen
persed in the heavens without any regula
they also appear of different degrees of
ness; in consequence of this, they are

[2] The stars, although called fixed, are not
so, as astronomical observations have proved th
in motion; but their distances are so immense
motion is scarcely perceptible in half a cent
supposed, that there may not be really one fix
the heavens, but that on the principle of att
one star be in motion all the others must
thereby.

first place, divided by astronomers into different groups, to each of which is given a figure, which is called a constellation; and every star in each constellation is distinguished by a letter of the greek alphabet. Thus a number of stars near the north pole, is called the Great Bear; because the principal stars which compose it are at such distances as to take up in a space of the heavens the figure of that animal, and so on of the rest. In the next place, the stars of these constellations are divided into six different classes; those which seem the largest and brightest, are called stars of the *first* magnitude; and the smallest we can see with the naked eye, are called stars of the *sixth* magnitude: in consequence of this arrangement, there is scarcely a visible star, the situation of which in the heavens is not better known than that of most cities and towns upon the Earth: but it nevertheless appears, as if in mockery of the efforts of puny man in attempting to scan the works af an infinite Being, that even this nice arrangement is subject to defects from the sudden appearance of new stars in places where none had before been observed, and from the sudden disappearance of old ones: a circumstance of the latter kind first induced Hypparchus to make a catalogue of the stars as they appeared in his time, that posterity should be better able to notice the changes that might afterwards ensue. In 1572, Cornelius Gemma discovered a new star in Cassiopea, which was so bright as to be seen in the *day time, which* however gradually diminished, *till at the end* of 16 months it entirely disap

peared. A similar star appeared to Tycho Brahe; and in the year 1604, another was seen by Kepler, in the constellation of the serpent, which gradually disappeared likewise. In 1696, a new star was discovered ("the Stella Mira,") in the neck of the whale, which is found to appear and disappear periodically: several other instances of the kind occurred after the invention of telescopes; and of late years, the circumstance of new stars suddenly making their appearance, and then fading away, is by no means uncommon.

The hypotheses advanced to account for these remarkable appearances are ingenious, but of course must be considered as mere speculative assertions, and perfectly incompetent to demonstrate the truth; if we consider the fixed stars as suns, we may imagine upon the disappearance of an old star, a whole planetary system to be dissolved, and upon the sudden appearance of a new one, that a new system is called into existence: but it is vain for ephemeral man, the creature of a day, to attempt to account for the wonders he beholds. It is enough for him humbly to adore the great Creator and ruler of all; perhaps when the soul has "shuffled off this mortal coil" the knowledge of all these sublime particulars, may be a part of the joy and felicity of that better state to come.

It is the general opinion and it has been before observed, that each fixed star does not shine by the reflection of the Sun's light, like the Moon and the planets, but by a light of its own: we therefore conclude them to be SUNS which are

the centres to systems similar to ours: it is certain that they shine by their own light, for it appears impossible that rays from our Sun should be sent to them, and then transmitted to us; for how faintly does Saturn shine, notwithstanding his immense bulk; and yet his distance from the Sun is nothing compared with that of the nearest fixed star: we are authorized then to consider each fixed star the centre of some magnificient system, irradiated by its beams and revolving about it by its influence; thus God is glorified not only in one earth, but in an infinite number; his wisdom is magnified to a yet greater extent, and his beneficence and superintending providence made further manifest; and if the soul is lost in the exalted thought, let it not be forgotten that it is lost in the infinitude of his perfections.

When the stars are viewed by the naked eye, seldom a thousand can be seen at a time; but when we apply the powers of the telescope, the number of them is so prodigiously increased, that the understanding seems bewildered, and the faculties overpowered. In the Bible we find Job speaking of Orion and Pleiades, two constellations, the former of which does not appear to contain a dozen, and the latter not more than seven stars, but with powerful telescopes more stars have been discovered in these two constellations, than can be seen by the naked eye in both hemispheres. Every one who looks up to the sky on a clear night, will observe a long streak of light of a whitish appearance, stretching from north to south, which is called the milk

way; and in other parts of the heavens other white specks may be seen, which are called nebulæ.[3] Upon applying the telescope to any part of the milky way, or the aforesaid nebulæ, they are found to contain such immense numbers of stars, as to defy the powers of calculation. Dr. Herschel supposed that above 116,000 passed through the field of view of his telescope in a quarter of an hour. If it is difficult to ascertain the numbers of the stars, it must be doubtless as hard a task to conceive the immense distances at which they are placed from each other, or from our Earth.[4] The Sirius, or the

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[3] The most considerable nebulæ is one midway between the two stars on the blade of Orion's sword, discovered in 1656, by Huygens, and that of Andromeda, seen by Simon Marius, in 1612; others may also be clearly distinguished in Sagittarius, Serpentarius, and Hercules. Dr. Herschel made catalogues of 2500 nebulæ, and clusters of stars, discovered by the aid of his grand telescope; some of these form a round compact system, others are more irregular, and some are long and narrow. From his observations upon them made during a period of thirty years, he considers them to form independent systems among themselves, and that our system is a part of a grander system which includes the whole of the milky way, and that all the stars of the first, second, and third magnitude, belong to that vast cluster or shoal of stars.

[4] The fixed stars are so remote that a diameter of the Earth's orbit bears no proportion to their distance, or if viewed from one of the fixed stars, would appear as *a point*, as the fixed stars have no sensible annual parallax, which is proved by the apparent place of any star in the heavens being always the same, although observed by the aid of the best instruments from oppo-

Dog Star, which is the nearest to us of all the stars belonging to the stratum in which our solar system is placed, and of which one sun forms *one star* of the innumerable multitude, is supposed to be 400,000 times the distance from the Sun that our Earth is, which is 400,000 times 95 millions, or 38 *millions of millions* of miles, so that a cannon ball would take nearly 9 millions of years to reach one of them: increase the powers of the telescope to what extent you will, still no limits can be found to the vast expanse, and no end to the continued succession of new stars: millions upon millions still pour their light upon the astonished eye, and this light which is supposed to travel at the rate of 12 millions of miles every minute, according to the assumed distances of some of them, must have left the stars we behold more than 40,000 years ago.

But all the stars that decorate the sky, the increased and still increasing myriads which the most powerful telescopes have discovered, are but a spot, speck, or mere point, in comparison with the unfathomed infinity which lies beyond

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site points of the Earth's orbit; it follows that the distance of the nearest fixed star, allowing its parallax to be two seconds, whereas it is not even one, must exceed, at least 100,000 times the diameter of the Earth's orbit, which is the base of the triangle it subtends; the diameter of the Earth's orbit is 190,000,000 miles, this multiplied by 100,000 gives the distance of the *nearest fixed star*, or 19 billions of miles; but as *the parallax is even* less than 1″ the distance must be *proportionably greater*.

them: consider the whole of these what they really are,—"suns lighting systems with their joyous beams;" consider the millions whose light have not yet had time to reach our Earth, through the immensity of their distance; but conceive them all but as a few particles of dust floating upon the sun beams, a handful of sand taken from the sea shore, or as a single drop of water in the sea, when put in comparison with that Eternal Spirit, whose love at first created, and still guides and sustains the whole in their rapid courses, calm, regular and harmonious; and who, from this immeasurable height of majesty and glory, looks down upon the humble heart, communes with it, and shines in it,

"As shines the sun beam in a drop of dew."

All that is fair, and bright, and glorious,
Of matchless grandeur and sublimity;
And all of beauty that breaks forth and shines
To the enraptured sense; the sights and sounds
Of ever varying nature; all are *Thine*.
Thy presence, Lord, is beaming through their power
With a transcendent brightness; when afar,
The flowing sea's sublime monotony
Is borne upon the zephyrs; or the thunder,
Robed in the dun of thickest night, rolls on,
Like all triumphant victory, that brings
Shouts at her chariot wheels: why Thou art there
Thou the Omnipotent! guiding the fierce fires,
That rush like mighty coursers through the sky,
And hurling forth the storm: nor less art Thou
Amid the soft and sweeter beauties of
The green and happy earth: in every tint
Of soft chamelion changes that array
The blithe young morning in ten thousand charms

And in the brightness of the mid-day cloud,
And in the blushes that make holy eve's
Enrapturing closing, and in every hue
That mingle in the rainbow: in the mild
And tender solace of the chaster moon,
And in the glowing stars, thy presence beams
Ineffable. But 'tis not only here
Upon this *outward world* thy glory falls:
Does not the stirring spirit of mean man,
That *inward world* of never dying things,
When thy Eternal light pervadeth it,
Sparkle more gloriously? and hath it not
A beauty more transcendant, lovely, bright,
And all surpassing than great nature hath?
For though her glittering diadem of stars
Seems like a token of eternity,
Yet she shall be no more!—Whilst *Thou*, oh soul
Imperishable in thy Creator's love,
Shall Phœnix like, but on sublimer wing,
Soar from the all consuming flame to heaven,
And flourish o'er the ashes of a world!!

CONCLUSION.

We now draw towards the close of this truly ublime and highly interesting science, which ay be said to be one born amidst solitude and anquillity, nursed by patience, and brought up the very arms of religion and devotion. We ve beheld a *part* of the immensity of the uni- rse, we have had exhibited to us the beautiful chanism by which it is regulated, and are be- ne acquainted with the simple but efficient s *by which it* is governed and preserved. *have also beheld* the mind giving fresh to-

kens of its immortality from age to age, i
capacity to comprehend those laws, and i
grandeur of its conceptions concerning th
so far above the apparent limits of human un
standing. Captivated by the harmony of th
lent and never ending revolutions of the hea
bodies, man is irresistibly led to indulge i
noblest speculations that can engage his a
tion; and lit by a spark of the divine ess
he is enabled to contemplate the *Creator* i
glorious perfections, and is made familiar
his goodness, his wisdom, and his power;
would fain shake off the corruptions of mort
and launch into the boundless realms of s
feeling that every step he advances he is br
nearer and nearer to the Divinity, and fa
removed from the discords and distractions o
nether world; but that divine gift Reason, w
has taught him to measure the planets, a
calculate their distances, and the period
their revolution, with unerring precision,
pers that there is a point at which he oug
pause: he knows he is certain that the ti
but short ere he shall be called to enter u
state of existence far superior to what this
can afford him; and revelation informs hi
his consolation and comfort, that "eye ha
seen nor ear heard, neither have entered in
heart of man the things which God hath
pared for those that love him."

——————— Yes, Thou shalt spring,
Immortal spirit. Yea, from out the dust,
And all will be revealed: Thou can'st not bear
That flood of glory now. Thy eye half dim
With tears; thy aspirations made in sighs;
Thy high conceptions;—what are they? how weak!
How vain! how abject! Why the whole
Of boundless space, with all its glittering stars,
And suns, and wheeling spheres, and satellites,
Could mortal eye take the vast compass in,
With the bright choir of angels, hosts seraphic,
Legions of towering cherubim, and ranks
Of the high archangels in all their glory,
Would be a sight but mean and poor, compared
With that which doth await thee,—Thou shalt look
Upon thy God.

END OF PART THE FIRST.

PART THE SECOND.

GEOGRAPHY

AND THE EARTH.

How beauteous wert thou, Earth, when fair and new
From thy Creator's hand, thou first didst move
In calm and silent grandeur, with the smile
Of the Eternal round thee, and with man
Formed in His likeness glorious; and great
In perfect innocence.—Then tigers played
Meek with the kid and lamb, and the sweet dove
Nestled at night beneath the vulture's wing;
While night's choice bird would, on the eagle's ear,
Pour its melodious hymn; then beauty threw
A heavenly radiance on the serpent's form,
So heavenly, that it seemed as it were sent
For man to worship daily; then the herb
Put forth its bloom unculled by misery's hand;
And, oh! the shrivelled lip on morning's dew
Sighed not its fevers, and the burning brow
Scath'd not the rose that bound them. Then the sun,
In newest glory, had not known a cloud,
The moon a halo, or the stainless blue
Of heaven's pure arch, the shadow of a storm:
The glowing planets, and the sparkling stars,
Stood clear at midnight, and the waveless streams
In which their twinkling was reflected full
Till morning's dawn, spoke of the certain peace
'Twixt Earth and Heaven, whose all admiring sons
Came down to muse with man, and teach him how
To speak the joy befitting such a time.
Oh! blessed holy time, when joy but raised
Her voice in gratitude for blissful things:

Ere hearts began to leap at human woes,
Or at a brother's fall. Ere blood had paid
The deed of blood; or ere the front of Heaven
Was blooded by Earth's carnage, and gaunt death
Shook his black crest exulting o'er the plain,
By cursed ambition strewn. The laurel grew
Twined with the olive, on fair Eden's banks,
The hero's mailed hand had not yet torn
It thence to flourish o'er his gore-stain'd brow,
To draw the homage of a trembling world.
Woman's fair speech had not brought death to man,
Nor man's offences drawn the thunders down
From wrath enkindled skies, mingled with fire,
Tornado, torrent, and wild whirlwind.——Calm,
Silent, and gorgeous hung the canopy
Of azure heaven, over the emerald deep,
That shew the rocks of flawless crystal, and
Masses of virgin marble like a mirror,
Reflecting all the purple hooded hills
And lofty mountains to their very tops,
In all their herbage green: All! all! was peace,
Beauty, and glory, and sublimity;
Divinity's first law!—'Twas then that God
Moved in his mighty essence thro' the walks
And shady bowers of Eden;—Happy man
Met him with open forehead, pure at heart,
And heard his voice with joy.
————————————Where, where are now
Those streams, those holy hills? Euphrates lies
Like a fond mother all dishevelled, bare,
That weeps her first born son: Pison is fled,
And frantic looks the rock above her bed:
Gihon wails lonely 'mid her desert wilds,
And Earth is still more desolate and lone,
And full of horror.—Yet, redeeming God,
There is a paradise,—an Eden still,—
Where THOU dost love to walk at eve or morn,
And where thy angels yet on earth converse,
And where thy spirit smiles:—'Tis in the heart,
'Tis in the bosom sanctified by Thee.

was accomplished in about 25 years. There are Roman Itineraries still extant, which shew the accuracy with which the survey of the different provinces were made.

Geography was not however at this period a new science in the world, nor were the Romans the only people who delineated their conquests upon maps. Neco, King of Egypt, ordered the Phenecians to make a survey of the whole coast of Africa. Darius procured the Ethiopic Sea, and the mouth of the Indus to be surveyed; and in the time of Socrates it is evident that maps of some kind were in existence, as the philosopher is represented as mortifying the pride of Alcibiades, by desiring him to point out his territories in Attica on a map. Alexander also, according to Pliny, took with him into Asia, geographers to measure and describe the roads and routs of his army.

From the death of Alexander, geography went on improving till the time of Ptolemy, in the second century of the christian æra; who by a more accurate delineation of the terrestrial globe, contributed greatly to the improvement of the science; he in fact, reduced geography to a regular system, and laid the foundation for all succeeding discoveries.

The World as known to the Ancients.

The ancients were acquainted with but a very small portion of the globe, compared with the *moderns*, and the appellations Europe, Asia, *and Africa*, were only given to small districts: *these however* gradually extending, became at

last of such considerable magnitude, as to be called quarters of the world. With respect to Europe fixing the time of the 12 Cæsars as a period to date from, we find the ancients to be well acquainted with by far the greater part; for as far as the Danube and the Rhine had been traversed by their arms, and owed them subjection; they were also acquainted with Britain from the expeditions of Julius Cæsar and Claudius; although the inhabitants were at that time nations of uncouth savages. Augustus Cæsar also sent a fleet to the Baltic, which sailed as far as the modern Jutland and Denmark, which was called the Chersonesus Cimbrica. Iceland is supposed to be the "Ultima Thule," the boundary of their geographical knowledge to the north.

The ancients had surveyed Asia as far as the Ganges, concerning the countries beyond which their information was very imperfect. Africa they had explored only to the cateracts of the Nile: the interior of Africa they knew nothing of. The parts along the coast washed by the Mediterranean sea, opposite their own territories, partook of the Roman splendour, and were once covered with dependant towns, eminent for their commerce, and all the arts and luxuries of civilized life. During the declension of that vast empire, when barbarous nations were pouring in upon it on every side, it cannot be expected that this science should be exempt from the common fate that awaited all others.

In the middle ages, during the profound and *universal ignorance* that prevailed, Geography *went backwards* rather than advanced: fo

nearly 1000 years but one geographical discovery of any importance was made, which was that of Iceland by a Norwegian navigator. The discovery of the magnet about the year 1302, may be considered the most important of all discoveries, as relating to the science of geography. In 1360, Nicholas Lynn undertook a voyage to the north to prove its virtues; and in the fifteenth century the Portuguese discovered and colonized the Island of Madeira; in 1446, Cape de Verd and the islands opposite it were visited, and in 1471 the equator was first crossed, and Bartholomew Diaz descried the Cape of Good Hope. The greatest and most enterprising geographer that ever existed, now appeared: this was Christopher Columbus, who, from the most accurate calculations and surmises, imagined land to exist across the ocean towards the west. Convinced that such was the case, and having a head to plan and a heart to undertake the most daring enterprises, Columbus applied to almost every court in Europe to grant him assistance towards fitting out the necessary vessels to prosecute his designs. But he was treated with scornful neglect by some, and ridiculed by others, till at last, when worn out with continual supplication, and almost desparing of success, the Almighty, to whom in all his difficulties he never ceased to pray, raised him a patron in Isabella of Spain: with her assistance, and the sacrifice of the remainder of his fortune, three small ships were equipped, and on the 3rd. of August, 1492, he set sail from the shores of Spain with a fair wind, which

ver failed him till the shores of America
ve in sight.

From this time numerous adventurers offered
ir services in exploring different parts of the
rld, and vast additions were daily made to
stock of geographical knowledge, by new
coveries in both hemispheres; while honour
d interest impelled both individuals and na-
ns to fit out expeditions for still further disco-
ies: at last, to prove the conjectures of some,
solve the doubts of others, Ferdinand Ma-
lan undertook the circumnavigation of the
be, and sailed from Seville on the 10th. of
gust, 1519, and on the 6th. of November
owing entered the strait which still goes
his name, at the southern extremity of
nerica, and passed into the south sea:
ering north he soon afterwards reached an
known ocean, which he termed, from its tran-
llity, the Pacific: in prosecuting his voyage,
in March, 1521, discovered the Ladrone
nds, and afterwards the Phillipines, on one
which he was unfortunately killed in a skir-
h with the natives. The ship, under the
mand of Jean Sebastian del Cano, passed
Borneo to the Moluccas, from thence by the
natran group of Islands, and the Cape of
od Hope, direct to Seville, (the port from
ch it started), in September, 1522, after a
age of above three years.

t was now generally imagined, that a south-
continent of considerable magnitude existed,
that a shorter passage might be made, be-
the northernmost land of Europe or of

America, to the East Indies: although neither of these opinions have been realized, they have been the cause of many important discoveries being made. Martin Frobisher, in attempting a north-west passage, made us acquainted with West Greenland and Davies' straits: Hudson's Bay, and Baffin's Bay, were discerned by the Captains whose name they bare, in the years 1585, 1610, and 1662. In 1616, Le Maire and Schouten, in search of the ideal southern continent, explored the strait called Maire's strait, and made other discoveries: while in the same year Batavia, New Holland, and the southern part of Van Dieman's Land, were discovered by some Dutch navigators: and Abel Jansen Tasman, of the same nation, discovered New Zealand and the Friendly Isles, and demonstrated that New Holland and New Zealand were insular. The Carolines were found out by the Spaniards, and Britain and New Ireland by our countryman Dampier.

Of late years, the governments of several European nations, have given encouragement to geographical enterprises. England in particular fitted out two expeditions, in the years 1818 and 1822, under the command of Captain Parry, for the purpose of ascertaining if a north-west passage did really exist; and although success did not follow the exertions of a hardy commander and a brave set of men, to the extent that might be wished, yet having penetrated to 118 degrees *of longitude, in* the highest northern latitude *ever attained,* collecting in their voyage many *singular facts,* and rectifying many mistakes in

ıe charts of former navigators: it may be af-
rmed, that these late expeditions have benefit-
ed science in a very eminent degree, and that
ıey add a glory to the government who sancti-
ned the enterprize, and to the monarch who
ave it his countenance and support.

The EARTH and SEASONS.

Oh thou eternal God of love,
What beauty in thy works appear!
Where e'er we turn, where e'er we move,
Still shines thy goodness bright and clear;
The Seasons in their proud array,
The kind vicissitudes of day!

How sweet it is, how passing sweet,
To see the slow expanding flower,
Turn fondly to the genial heat,
Bathed richly in the passing shower;
While painted on the vernal sky
The rainbow softly smiles on high!

When golden Summer casteth bloom
In fragrance on the sunny air,
And glow-worms struggle to illume
The swathy night, and make her fair;
These! these! would lift the heart to thee,
The good and bounteous Deity!

But when brown Autumn loves to pour
Her rich profusion o'er the soil,
While day on day encrease the store,
Rewarding man's unsparing toil,
Will they not bend the humble knee
In gratitude, Great Lord to Thee.

Nature feels this, but faith can feel
Far more—can feel, amid the storm
And wintry blast, some charm to heal
The stricken heart, some love to warm
It in the chilly hour, and throw
Sunshine upon the darkest woe.

CHAPTER I.

The Earth, its Figure, Motions, causes of Day and Night, and Change of Seasons.

In page 40 we merely considered the Earth as a planet; we shall now furnish the reader with other particulars relating to the globe we inhabit. The figure of the Earth is what is called an oblate spheriod, and is rather more elevated at the equator than at the poles; the equatorial diameter exceeding that of the polar about 34 miles, which difference is supposed to be produced by the motion of the Earth round its axis. That the Earth possesses a spherical form is proved first, by our beholding from the sea the tops of mountains, and the masts of ships, before we see their bases or their hulls, secondly at the *time of a lunar* eclipse, which is occasioned by *the shadow of the* Earth falling upon the disk of *the Moon*, we always notice that the shadow is *bounded by a circular line*.

he Earth is divided by geographers, first
five zones or climates, two frozen, two tem-
te, and one torrid zone; and again into
quarters called Europe, Asia, Africa, and
erica. The boundaries of the different zones,
marked by different imaginary circles at
ain distances from the poles and equator.
circles which mark the boundaries of the
en zone, are distant 23½ degrees from each
ie poles; between these two circles and the
ator, other two circles are described, the
in the northern hemisphere being called the
ic *of Cancer*, and that in the southern he-
phere the *tropic of Capricorn*. The parts of
world lying between these two circles, and
two polar circles, belong to the temperate
es; while all the countries lying between
e tropics having the equator (which divides
earth into two equal parts) for their centre,
what is called the Torrid Zone.

Of the Earth's Motions and the Seasons.

he Earth has two motions, both of which are
west to east, one called diurnal, the other
ual. The first of these is the daily motion,
performs round her own axis, the other is
yearly revolution round the Sun. By these
ons and by the inclination of the Earth's
to the plane of the ecliptic, is produced the
ıtiful vicissitude of the seasons, and the va-
on *of the length* of the days and nights.
e *the axis of* the Earth perpendicular to the
ic, *the sun's* rays would be diffused equally

over one half of the globe's surface at a time, and the days and nights would be of the same length; that is of 12 hours duration in every part of the Earth.

But instead of this, we find that the day varies, not only in the different seasons of the year, but in different parts of the world. To begin at the equator, or in the countries under the tropics, the day is found to be nearly of an equal length all the year round, while more northward in the latitude of this country, for instance, or at its antipodes south; there is found to be sunshine in the summer season, for about 16 hours; while in the winter, eight hours only elapse from sun rise to sun set; if we proceed to the countries adjacent to the north or south pole, we shall find the day to consist of six months, and the night of six months also. The reason why the countries between the tropics have their days nearly of equal lengths all the year round, is, because the inclination of the axis of the Earth cannot so sensibly affect her equatorial parts, as her polar ones, which are by their position naturally thrown more into the sun's rays in summer, and out of them in winter.

The length of the days and nights, or in other words the continuance of sunshine upon the different parts of the Earth, produces the vicissitudes of the seasons: for the more sunshine we have the more heat is communicated to the Earth; and consequently when the sun affords but eight hours light and 16 of darkness, and when during those eight hours the sun's rays

only fall obliquely upon the Earth's surface, vegetation must necessarily be dormant; but when the Earth attains that part of her orbit, in which she receives the sun's rays something less obliquely, and of longer duration; this increase of light and heat calls the powers of vegetation into action, and produces the various phenomena of Spring. At last, certain parts of the Earth being in such a situation as to receive the sun's light for 16 hours, bring vegetation to its fullest perfection, and this period is called midsummer: from this time the quantity of sunshine begins to diminish, and when the Earth comes to that point of her orbit, opposite to that at which Spring commenced, the days and nights are again equal, and AUTUMN is said to begin, and as the sunshine still continues to diminish, and the rays fall more and more obliquely on the Earth, the cold increases, till at last the Earth being in the same point of the heavens at which we first described her: her axis being in that part of her orbit, in which its position is away from the sun, the Season is called WINTER.[1]

It must here be observed that this variation of temperature, and the consequent change of Seasons, is less felt as we draw near the equator. In parts situate between the tropics, there are but two Seasons, the dry or Summer Season, and the wet or Winter Season, in which heavy

[1] The order of the Seasons, and also the lengths of the days and nights in the southern hemisphere, are reversed to those of ours; that is to say, when we have Summer, they have Winter, when we have days sixteen hours long, they have them only eight hours.

torrents of rain are known for weeks together. In high northern latitudes there are also but two seasons in the year, a Winter of nine months through which frost and snow suspend the operations of nature, and a short Summer of three months; in which however vegetation shoots into perfection so rapidly, that all the necessary operations of budding, blossoming, fructification, and the shedding of the seed, is performed in about a third of the time taken up in climates where the warmth is of longer continuance.

What a beautiful specimen does this afford, of the wisdom and providential care of the Almighty; without this wise arrangement, which has the appearance of a miracle, vegetation would be extinct in a Season.

OF THE COUNTRIES WITHIN THE

POLAR CIRCLES.

'Mid the eternal snows,
And the interminable plains and pinnacles
Of crystal ice—He lives—The Deity
Still moves in his sublimity and power
And beauty through the whole!—Go where thou wilt,
Aspiring essence of degenerate dust;
Like the good Prophet, take the whirlwind for
Thy chariot, with steeds of flaming fire,

Whose hoofs are armed with rattling thunder—still
Thou never canst be borne where He is not,
Nor where his love doth not preside :—cast down
This earthy husk that prisons thee ; and pierce
The ice bound bosom of the frozen deep,
Or bathe thyself in the resplendent sea
Of streaming light, that clothes the atmosphere
In glory—thou wilt find him there.——If bliss
Be given to man on earth, 'tis even thus
To follow the Most High, and still to see
His presence ever beaming through His works.
Methinks if man were all alone—removed
At His good bidding far from all mankind,
With nought around him, save the savage forms
Of ice crowned mountains, or the majesty
Of the storm daring cedar to o'ershadow
His kindling brow ; that even these would bring
Sensations of devotion, and beget
Thoughts that His SPIRIT would not scorn—but led
By a philosophy that loves to blend
His truths with all the sights and sounds that fill
The smiling scenes of earth, the arch of heaven,
Is he not happy who hath scope and power
To meet Him thus ? and thus acknowledge Him—
His Lord—Creator—Saviour—God ?

CHAPTER II.

From the circumstance of the polar circles receiving the sun's rays in an oblique direction, and being for a considerable time deprived of them altogether, (the Winter being in those parts nine months long;) the countries round the poles present pictures the most desolate that can be imagined. As polar regions in the north have been the most *frequently* visited by Europeans we shall *confine ourselves to* them, rather than descend *into the south. In* the northern polar circles ther

are found vast mountains of ice, and dreary plains of frozen snow, which extend themselves in every direction, the monotony of which is only broken by here and there a horrid chasm, or an abrupt and dangerous precipice: while the ocean during a long and cheerless Winter, is frozen to an immense thickness in every part: presenting nothing to the eye but a rough and trough-like extension of ice, the boundary of which is only broken by some hideous ice-berg round which the biting blast raves in continual discord, while a few prowling beasts of prey, and a few wandering tribes of savages, each endeavouring to preserve a miserable existence, by the destruction of the other, are the only living reliefs to so miserable a picture.

In Summer, however, the scene is changed, and as the Sun rises upon the polar horison, the snow and ice begin to melt, and vast plains before covered by frozen snow exhibit scanty portions of heath and land; as the Summer advances, vegetation is observed to spring up with remarkable avidity, and in the course of a week or two, the plants and herbs peculiar to the climate are seen in blossom. Upon the bosom of the ocean, alterations more striking and sublime present themselves, while noises similar to those produced by the discharge of many thousand pieces of ordnance at a time, are heard in those parts where the ice begins to melt, from the vast piles of ice being loosened from the tops of high mountains, and rolling on the plains below; or from the sudden collision of the enormous masses that float in the open sea. These

masses of ice are sometimes from 1000 to 2000 feet high, and present the most fantastic and varied appearance to the eye. Sometimes they are seen to assume the shape of a gothic cathedral, with all the luxuriance of sculptured detail; its ornamental pinnacles and pyramidal points, with its enormous buttresses and bases, and its lofty spires: at another time they have the appearance of rugged mountains, exhibiting crystals of various colors, which decreasing in size as they melt, change their forms in an almost endless variety, till the Winter sets in, when they begin again to increase both in height and magnitude, by the freezing of the spray of the Sea, and the accumulation of the snow which falls on them; while on the fragments hurled from their pinnacles at former periods which float around these gigantic masses, hundreds of seals are to be seen frolicing in the sunshine, and here and there a solitary Walrus suckling her young, or perhaps a bear riding alone on some detached portion of ice separated from a larger body, howling piteously at his forlorn situation.

Dreary as the scenery and objects of the polar circle may be, the beauty of the heavens fully compensates for its most disheartening features: for peculiar to these latitudes are the Aurora Borealis, and the Lumen Borealis, which serve to illuminate the tedious winter of the inhabitants of those climates. In the Aurora Borealis are seen long broad streaks of various colors, *stretching from the* horizon towards the zenith; *sometimes they* assume a fiery, sometimes a *purple hue, and* at others a remarkable white-

ness, having a vividness of glare almost as intense as lightning: when, however, the coruscations are uncommonly bright and streaming, the term Lumen Boreale is applied to them. The Lumen Boreale are seen in the form of flaming spires or pyramids, having vapors between them of a blood red colour, which give the atmosphere the appearance of blazing lances, and bloody coloured pillars, interrupted by streaks of an intense yellow, which often increases to such a degree as to make the whole face of the heavens resemble a sea, with waves of fire mingled with blood.

Other remarkable atmospherical phenomena are also seen in these latitudes. Meteors that assume a thousand strange and romantic appearances; and the shore, when viewed from the sea, presents quite a different appearance to what it has naturally; for the atmosphere there partakes at times of the nature of a lens, and will bring parts of the land into view, although more than sixty degrees distant. David Crants, in his History of Greenland, and our modern adventurers, Parry and Franklin, also bear testimony to these facts, as they have noticed these particulars, and recorded them in their journals. Sometimes the whole range of shore presents the appearance of a wood, sometimes are to be seen the most grotesque figures such as windmills, fortifications, articles of household furniture, ships with sails and colours flying, and elevated castles with decayed turrets, which are observed to retire aloft, or appear distant, and then vanish; while at other

new islands appear to rise from the sea, having houses, trees, &c. plainly delineated; with ships riding in the harbours. The cause of these illusions seems to be the condensed mists hanging in the air, that reflect back as mirrors would, the images of things under various distortions. The solar rainbow also puts on a different appearance within the polar circle, as does the lunar rainbow, which is often seen; for being reflected from the bosom of a frozen cloud, they no longer exhibit the primitive colors, but merely a pale white, edged with dusky yellow, or striped with grey.

The inhabitants of the arctic regions are very short in stature, rarely exceeding five feet in height; their complexions are a sallow olive, and their features round, and to a civilized European unprepossessing. They are composed of wandering tribes, who roam about carrying tents with them, without any fixed habitation in the summer, and bury themselves beneath the snow during the winter season. They obtain their sustenance by hunting and fishing, depending more however upon the supply of seal, whale, walrus, and other sea animals, than on those of the land for their support. These they prefer most when nearly putrid, and delight in enriching their dishes with vast quantities of oil, which they procure from the fat of the whale and other fish. These people display wonderful agility and address in their occupation of hunting *and fishing: seated* in his kajak, which is a ca*noe about six* yards long, in the form of a wea*ver's shuttle,* made of lath and hoops, and co-

vered with skin in every part but a small hole in the middle; the Esquimaux pushes his body through the hole thus left in the centre of the canoe, and tucking his garment round the rim in such a manner as to exclude the water from the body of the kajak, he rows along the sea with wonderful velocity; in boisterous weather perhaps the waves breaking over him incessantly, sometimes overturned, with surprising dexterity he recovers his proper position, and is thus enabled to live through a storm to which Europeans, with all their advantage of knowledge and science, would fall victims.

Among these tribes of people who are superstitious and credulous; some as may naturally be supposed, pretending to supernatural powers, hold considerable influence over the rest, and fill their minds with the wildest fancies, concerning the natural phenomena of their climate, and a future state. They imagine that the Aurora Borealis is caused by spirits sporting in the atmosphere, and that the air, the ocean, and the tops of inaccessible ice-bergs contain beings of both benevolent and mischievous intentions; while they believe that after death they shall enjoy a perpetual Summer, beyond the frozen boundaries of their wanderings, where seals and wild fowl will be hunted without toil, and served up to them in the company of deceased relatives and friends.

Although thus immersed in ignorance, and the *grossest superstitions*, yet these rude uncultivated savages, exhibit virtues of which the most polished nations of the Earth might be proud.

Hospitality is practised to all; those who have been fortunate in their toils, distributing with an unsparing hand, to those who may have been unsuccessful. Heinous offences among them are of very rare occurrence, and it is said that their language does not contain any words expressive of cursing. They laugh at the ridiculous formalities of Europeans, which result from difference of station, and behold with indignation the oppression of the strong against the weak, and are struck with amazement at any acts of indecency, while the general tenour of their behaviour towards each other is that of gentleness, which even extends to their feats between competitors and to their quarrels, in neither of which rudeness of behaviour, or the encouragement of passion is allowable: they are also remarkable for speaking the truth. That many of these tribes, especially the more solitary and remote ones, present individual exceptions to these virtues, is allowed; and it is also worthy of remark, that other parts of their conduct is in direct contradiction to the ones we have here numerated, and the spirit of revenge is unfortunately perpetuated through many generations, and is suffered to sprinkle with blood the snows around their habitations; exhibiting to us, how insufficient is natural religion, although amidst the greatest simplicity of living, and abstraction from the busier world, to regulate the conduct and to preserve the mind from the stains of infamy *and crime*; whilst then this state of *society, may in* many instances convince us that *the spirit of the* Almighty is not entirely denie

to these poor savages; we ought, nevertheless, to offer up continual thanksgiving and praise to Him, for the love manifested to us in the revelation of His will: and while we admire the higher qualities of the savage, let not *us* who have greater proofs of divine mercy spread abroad among us, fall short of *him* in moral perfection; nor in reprehending his grossest vices, forget that we also are *men*; and that the state of existence in which we are placed (the state of civilization) presents far greater temptations to sin, than even the bleak snows or icy mountains of the polar circle.

OF TROPICAL CLIMATES,

AND THE

Natural Phenomena of the Torrid Zone.

The fool hath said in his heart; there is no God.

Psalm 14, *v.* 1.

And who is he
That saith there is no God? What is it man,
With ears, eyes, soul? Oh! Essences of love
Blooming around in precious beauty, speak;—
Speak ye soft airs that call the budding flower
To sun bright glory, and ye grateful showers
That raise the healing herb,—Autumnal gales
Wafting its seed to root in other meads,
Speak that there is a GOD: speak when ye bear
The scents of spicy isles across the wave,

Or gambol briskly on the headlong rock;
Or when your plaintive notes the caverns fill
With echoes made eternal! Answer him,
Proud ocean, in thy mighty ebb and flow,
Or in thy teeming solitude, or where
In fiery wonder through the night thou shinest,
Swarming with being, animation, life,
And still increasing germs! Speak from thy wild
And vast interminable increase of rude
And foaming billows; aye and from thy depths
Unfathomable, where grow the coral rocks
'Mid piles of crystal; and where sparkling shells
And living pearls, and glittering gems extend,
Glory and beauty through a world unseen:
From thence, and from the bottomless abyss,
Deign, deign, to raise a soul convincing voice
That the ETERNAL reigns!—Ye inland streams,
Nile in thy yearly floods, and ye that roll
Gold bedded through the trans-atlantic shores,
Or 'mid the gorgeous splendour of the east,
Where the proud pheasant and the rosy dove
Stretch their soft pinions on a golden sky!
And Oh ye glorious cataracts that leap
From the wild mountain tops in extacy,
Wing'd by the beauteous halo:—raise a voice
In your exhaustless thunders, that *He* reigns—
That GREAT JEHOVAH reigns!—Ye solemn heights
Of purple gloom, where solitude doth love
To lift her heart from sublunary things;
And where the rainbow on each peak appears
Stretching its curved pillars on the sky,
A very smile in darkness; blend with all
The things of earth and air, as mercy blends
With all that is terrestrial, and speak
Of HIM in beauty still!—Ye elements!
That live in dire convulsion,—ye stern throes
That rend the marble mountain's flinty heart
As he of Gaza did the lion's jaws:—
Ye subterraneous fires—ye whirlwinds full
Of deadliness: Thou terrible monsoon,
And fierce tornado,—still through earth declare
The Glory of the LORD.

CHAPTER III.

Of the Products of Tropical Climates—Phenomena—Hurricanes—Whirlwinds—Tornado—Samiel—Sands of the Desert—Meteors.

In passing from the north pole to the torrid zone, we travel over a large portion of the habitable globe; but as our intention is to confine ourselves to the more striking features of creation, we shall here supply the reader with some of the principal facts relating to the phenomena of tropical climates.

We have seen at the poles vegetation scanty, and man and animals (with some exceptions, however, to the latter) diminutive and below the common standard:[1] in the countries near the equator, we find the reverse of this to be the case; for it is here that nature seems to revel in her fullest luxuriance; we find the landscape to afford the sublimest characters, the mountains tower above the clouds, and are clad with imperishable verdure; while the rivers, whose currents resemble seas, flow stately and majestic for many thousands of miles: vast plains also, of unknown extent, covered by vegetation of every description, and impenetrable forests that seem as they were co-eval with the earliest periods, afford refuge to almost every species of animal. It is here the larger and fiercer beasts

[1] The natives of America differ more in size than in features or complexion. In Greenland, and the high latitudes of North America, the inhabitants rarely exceed five feet in height, while the inhabitants of Patagonia, lying nearly at the southern extremity of South America, are six or seven feet high.

hold undisputed monarchy. The Lion, the Tiger, the Elephant, the Hippopotamus, the Rhinoceros, the Alligator, Crocodile, and the enormous Boa Contrictor, at mid-day may be seen emerging from their recesses, while at night their yellings fill the solitudes with discord, and the weaker animals with dismay.

The tropical seas are no less wonderful, in many places fathomless; by day they roll mountain waves, and by night these waves appear at times to be suddenly converted into fire,[2] which have a truly awful appearance. Waterspouts are also frequently seen in these climates. In many of the shallower parts of the ocean, the bottom is covered with vegetables, which make it appear as green as a meadow, on which thousands of turtle may be seen feeding luxuriantly. Forests of submarine plants, and coral which rise through them gradually form islands, that become the habitations of man. In these seas

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[2] This light and scintillation of the sea, is produced from various causes: M. Dangelet, a french astronomer, brought from these seas several kinds of worms that shine in water. Many learned men imagine the light to be produced simply from friction; others imagine it to arise from putrefaction, giving certain substances phosphoric qualities. The Abbe Nollet, however, declares himself convinced from a number of experiments, that the luminous appearance of the sea is caused by small animals, who emit a shining liquor or effluvium from their bodies, or who possess a luminous aspect.—Doubtless, either of these circumstances contribute to the appearances under consideration, and when one or more of them *unite, they produce* a greater degree of splendour *in the phenomenon.*

also, may be seen playfully sporting the beautiful Dorado, or Dolphin, whose brilliancy resembling green and silver with dashes of gold, no artist can surpass; while the lively flying fish, continually darting to a considerable height above the waves, appears to experience sensations of delight of the most extatic kind; and shoals of every kind of fish fit for the food or other purposes of man, are in their proper seasons seen skimming the coasts, as offering themselves for his necessities.

Nor is the air less prolific in these climates than in the earth and sea: teeming with every species of winged insect of the most resplendant hues, and brightened by the gaudy plumage of every variety of bird;—the Pheasant, the Parrot, the Quam, the Carasoe, the Cardinal, and the beautiful little Humming Bird, seem to clothe the very atmosphere with glory;—while Quails, Geese, Bustards and all kinds of game, administer to the wants of mankind.

To crown all, tropical climates yield the richest abundance of all sorts of grain, pulse, and vegetables, fit for the food both of men and animals; while the trees absolutely bow down to the earth, with every variety of fruit in the highest perfection; peaches, grapes, lemons, oranges, figs, pomegranates, dates, pine apples, tamarinds and odoriferous gums and spices, that send their fragrance over the bosom of the deep, for many hundred miles. Here, too, the wonderful banian tree, which, while it forms beautiful avenues and *cool recesses* from the heat of the sun, also *affords the finest* nutriment from its thousand stems,

with the stately cocoa, yielding food, oil, and wine, in the richest abundance, give continual proofs of the bounty of the Deity.

If tropical climates afford evidences of the beneficence of the Almighty, so do they also exhibit proofs of his majesty and power. Tempest and storm here put on their sublimest attributes;—the hurricane, the tornado, the terrible monsoon, and terrific whirlwind, scatter the proudest trophies of man's pride in the dust, and make man himself their victim and their slave.

OF TROPICAL HURRICANES.

Tropical hurricanes, like fire, seem to consume every thing before them. An awful stillness prevails before the setting in of an hurricane, with a dense, close, and misty atmosphere, which renders breathing difficult, and throws a heavy melancholic sensation over the spirits. The sun appears of the colour of blood, and the stars, when the hurricane approaches at night, seem increased in magnitude. Suddenly the sky is overcast and wild; the sea, which appeared before pent up with the horror about to ensue, soon swells upon the land, and rises into waves like mountains.

The winds are thunder,—thunder has no name,
'Tis the Eternal's vengeance clothed in flame.
Darkness malignant as the evil one,
Leaps on the whirlwind as his car and throne:
Havoc comes on, by storm and tempest driven,
Hurling with phrensied force the bolts of heaven.

The earth shakes, and appears to be convulsed with succeeding fits of tremor; an universal consternation and terror seem to prevail among animated beings; birds dart from their coverts distracted, and are carried by the fury of the winds into the ocean; the beasts of the field rush together, goring each other in their eagerness to reach a place of safety, which alas! is no where to be found: for trees are torn up by their roots, houses are blown down, or their roofs carried to a vast distance, every plant and blade of grass is laid flat to the earth, and the whole face of nature seems suddenly transformed from the full luxuriance of summer to the barrenness of winter.[3]

At sea the effects of a hurricane are no less distressing, in a moment perhaps a whole fleet is engulphed, which appeared riding in the fondest security, or perhaps numbers of dismasted hulls are seen dashed upon the rocks, or floundering upon the shore, the waves beating them to pieces, and the falling crags burying them underneath mountains of earth. When the hurricane has subsided, the picture that presents itself is truly heart-rending; in populous places, where whole towns have been blown down, we see mounds of earth and rubbish in one place, and trunks of trees in

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[3] As a herald to the approach of these tempests, a sm cloud is seen on the verge of the horizon like a bla spot; this is called by the sailors "the bull's eye;" t grows gradually larger as it approaches: at length, co *ing to the place* where its fury is to fall, it invests *whole of the* sky with darkness, and the hurricane be

another, mingled with dead bodies and the dying; men, women, children, and animals, all scattered about, some half buried among the ruins, some dreadfully mangled, some crushed to atoms; and if a surviver be seen, he appears driven to distraction at such an accumulation of horrors.

The Almighty has, however, been merciful even in the most dreadful calamities that can happen to man, by giving him a forewarning of the approach of these violent convulsions of the elements. Thus, if at the change of the moon, the sky appears very turbulent, the sun redder than at other times, a dead calm succeeds instead of the usual breezes, the hills are clear of those clouds and mists which usually hover about them; if a hollow rumbling sound, like the rushing of a violent wind, is heard in the wells and clefts of the mountains, the sky in the north west has a black and menancing appearance, the sea emits a strong smell, and rises into vast waves often without any wind, the wave itself forsakes its steady stream, flowing violently and irregularly at intermissions:—these signs predict that a hurricane will happen at the succeeding full moon; nearly the same signs happen at the *full*, before a hurricane comes on at the change,—by these indications, then do the planters and others in the west Indies, secure in many instances, much of their property, and are able to preserve the lives of themselves and families.[4]

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[4] *That kind of* tempest more particularly distinguished

THE MONSOON.

The setting in of the monsoon, or tropic
wind in the *east* Indies, very much reser
the coming on of the tornado in the west.
atmosphere grows suddenly dark, the hea
comes extremely opressive, and a horrid stil
pervades the bosom of nature; at last, the cl
having collected as it were from every pa
the heavens to one spot, are suddenly seen
ing their lightnings in a thousand direct
while the thunder, resembling the dischar
many thousand pieces of ordnance in the
rior regions, absolutely deafens the ear; the
descends in a deluge, while the tempestuous o
rolls from a black horizon, literally of dark
visible, a series of floating mountains, hea
under hoary summits, until they approacl
shore, when their stupendous accumulations
in successive surges, and break upon the be
every ninth wave being more tremendous
the rest: the noise of these billows is only e
led by the thunder, and the principal differ
is, that the thunders are only heard at inter
whereas the rolling of the sea is without i
mission.

Many other phenomena, peculiar to the c
tries lying between the tropics, afford proo

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by the name of tornado, is when, instead of the
cane making a line of destruction, the winds appe
blow from every point of the compass towards one
ticular place, when nothing can resist its fury,
thing being caught in the vortex, made by the
rapidity of the whirlwind.

the omnipotence of the Deity, and should serve to repress human presumption. In Egypt, the south winds are so hot that they raise blisters upon the skin, and almost stop respiration: followed at times by pestilence, whole nations are swept from the face of the earth. Another wind more dangerous than this, called the Samiel, instantly kills those whom it involves in its passage, whether beasts or men. But perhaps the most terrible tempests which convulse the face of nature, are the sandy tempests in Africa. Here we find a whole desert, many hundred miles in extent, resembling a troubled sea, the waves of which are sufficient to bury whole hosts within their bosoms. These waves rise up so fast, that in a very short time, a hill fifty or sixty feet in height, is transported from one place to another: the shifting of these hills are not always sudden, allowing at times the means of escape; more generally, however, the sands, in addition to their undulation and wave like appearance, exhibit themselves like dancing columns, sometimes reaching apparently as high as the clouds, turning on their bases as on pivots; sometimes moving with great celerity, and at others, stalking on with a majestic slowness, they would overwhelm in their march, if they fell suddenly, an army or a caravan. It appears, however, from the accounts of the most recent travellers, that these hills of sand are usually dispersed in the manner they are suffered to accumulate, that is to say, gradually diminishing in their progress, *till they by degrees* disappear: sometimes, how*ever, a furious wind* disperses them as by magic,

and it is in such cases that the greatest danger is to be apprehended.[5]

In addition to the phenomena we have enumerated, tropical countries are remarkable for the frequency and splendour of their atmospherical phenomena. Meteors, here assume the most brilliant appearance; sometimes the heavens seem to be all on fire, as they were noticed in French Guiana,[6] by M. Bonpland; and are related in Humbolt's travels to the equinoxial regions of the new continent. Thousands of fire balls and falling stars says that enterprising author, were seen for upwards of four hours, in a direction from north to south, during which time there was not a space in the firmament equal in extent to three diameters of the moon, which was not filled at every instant with blazing bolides or fire balls, many of which were observed to have very distinct nucleus, as large as the disc of the planet jupiter, from which darted sparks of vivid light. Sometimes these meteors might be compared to the blazing sheaves shot out from a fire-

[5] As the appearance of these sandy waves and columns is only visible during the hottest part of the day, they are supposed to originate in the solar beams, causing the dust of the desert to rise and float through the air, being formed into columns by the action of the wind; and it is thought, that only their gross particles subside after the wind has ceased, while the more minute ones are kept in an undecided and undulating state, till the cooler temperature of evening restores their specific gravity, when they sink to the earth.

[6] *The meteors* which appeared at Cumana, and in *French Guiana*, were visible in Greenland and in Germany.

work; at other times, bright rays appeared, from five to ten degrees in length, of a reddish colour, resembling the luminous track of a sky rocket, and in most cases the bolides seem to burst as by explosion; although the larger ones, whose diameter appeared from 1° to 1° 15′, disappeared without scintillation, leaving behind them phosphorescent bands, exceeding in breadth about the sixtieth part of a degree, which kept their brightness seven or eight seconds.

Such then are the phenomena of the torrid zone, which exhibit some of the most striking specimens, both of the omnipotence and the beneficence of the Almighty; and whether we turn to the tumults of the air, the rich profusion of the earth, or the luminous appearances of the sea beneath, or the heavens above, yet still we are compelled to confess, that "God is ever present, ever felt." In these more terrible convulsions of nature, we see the necessity of a lively and active faith; for beholding the terrors of his almighty will, the fragile soul of man would suddenly despair, were it not for that divine principle, which,

> From seeming evil still educes good,
> And better thence again, and better still.
> In infinite progression.
>
> THOMSON.

——————————— To him who holds
True faith within him, all the deadly rage
Of nature's strange convulsions will pass by,
And he will still be stedfast. He may sit
On the sea shore in wildest storms, may hear
Afar the sullen growlings of the thunder,
Or its loud crash above him; he may listen
To the destroying whirlwind's rush, the shrill
Lament of birds, the piteous moan of beasts,
And look upon the swoln and bloated cloud,
Gathering upon the firmament like rage
On passion's darkened visage, and not feel
Ought of despair or terror; he may see
The desolating lightnings singe the tops
Of gnarled oaks, or quiver on the wave
And smite the struggling sail, or rive the pine,
And cleave the mountains into horrid chasms,
Or dash down helpless man in rage to earth,
As some infuriate tyrant would his slave:
But yet in all, the watchful ear hath heard,
Or the oft blenching eye hath gazed upon;
Something of love divine will yet appear—
Something of mercy will not fail to beam
To him and to his spirit.

OF THE

Inhabitants of Tropical Countries,

AND THE

SLAVE TRADE.

Oh Thou, all righteous common Father—Thou
Great God of truth and justice, mercy, love;
Seest Thou not the woe, hear'st Thou not the cry
Of all:—The sons of Africa—they call
Unceasingly upon Thee;—tears—sweat—blood,
Fall thickly on the ever teeming earth:
Bitter despair, fierce madness, and the curse
From quivering lips and groaning bosoms, pierce
The sun illumined air:—Oppression sits
Through all,—cold, stedfast, and immovable,
With frowning brow and sullen eye,—her heart
Bound up in haughty mail—each firm twined nerve
Cased with untempered iron: Millions bear
The cruel blow and hateful spurn; the shrill
Shriekings of agony and torture, have
Been heard through many ages, and they still
Outvoice the struggling elements. But shall
These horrors smite the listening ears of heaven,
And men yet look on calmly? If the light
Of a Divine Philosophy hath beamed
Upon our clay,—If the aspiring mind
Hath in itself eternal germ,—If life
Be ought except the living for life's sake,—
If we do cherish in our bosoms, one
Unsullied spark of that illustrious flame,
That warmed our ancestors in freedom's cause,
And taught them honest hatred to detest,
At once the tyrant and the name of slave:

But more, if we do love the paths of Him
Who suffered under tyranny, and died
To save from *bondage* the immortal soul,
And dare to say we feel his spirit in us,—
It is for us—for all who boast his name,
To wage the glorious warfare; still to wield
The weapon of the spirit, and to fight
'Neath the joint emblems of the cross and dove,
Against the bitter tyrants of the world—
Against the world itself; while only one
Of earth's unnumbered millions shall continue
To bear the name of SLAVE.

CHAPTER IV.

Inhabitants—The Americans—Negroes—their Enlinement—History of the Slave Trade.

The aboriginal inhabitants of tropical climates, are of course various, those of the new world differing to those of the old very considerably: this difference appears to arise from the local situation of places; thus, the inhabitants of the midland parts of Africa are negroes, being entirely black; while the natives of America, although in exactly the same latitude, are in complexion merely a deep olive, because the hottest parts of America are either refreshed by breeses, or cooled by snow covered mountains; in addition to which, as the country is not overstocked with people, the inhabitants have an opportunity of choosing the most pleasant and salubrious situations.

The several native tribes of negroes then, may *be said to* constitute the real tropical inhabitants; *in fact, were* we to attempt to describe the ab-

original indians of the new continent, (more especially in those parts lying under the equator), we should speak of tribes that now may scarcely be said to have an existence; for on the discovery of America, the successors of Columbus put millions of them to the sword, and nearly exterminated the race; and succeeding generations of Europeans have scarcely been less merciful. All accounts however agree, that the inhabitants discovered by those who first visited America, were possessed of many virtues, and of a nobility of soul, to which cultivated nations are often strangers. They had made considerable advances in the arts; they had canoes, store houses, and regulations; and in their picturesque and emblematical drawings, they had made an essay towards the art of writing: and from later discoveries made among the Mexicans, it appears, that at no very distant period, they formed part of a nation, who had made very considerable progress towards civilization and the arts; as remains of their public buildings and temples have been found, displaying considerable magnificence. To rob them of their possessions, their wealth, and their country, Europeans hunted them down with dogs, as they would beasts of the forest; condemned some to the axe, and others to the flames, for not embracing a religion preached to them in a strange tongue; while the remainder were slaughtered by thousands, their villages burnt, and their country laid desolate. To supply the place of these exterminated Indians, another quarter of the globe is rendered wretched; and thus in the torrid zone, the most

melancholy picture of the depravity of mankind, is to be met with of any on the face of the earth.

The race of unfortunate beings fixed upon for this purpose, are the negroes, natives of Africa. These people from all accounts, appear to possess more humanity, gentleness, and kindness than any barbarous tribes; good-natured, social, honest, obliging, and hospitable to the highest degree; the negroes in their native vales, seem to enjoy something of the life of our primitive parents. Nature almost spontaneously supplies their necessities, and situated amid the most charming landscapes and fertile plains, they would, (allowing for the trifling vicissitudes of their mode of life,) enjoy an almost uninterrupted ease and happiness, but for the rapacity and lust of gold of Europeans.

We have described the afflictions and terrors to which tropical climates are subject, the destroying tornado, the devestating whirlwind, and terrible monsoon; but all the horrors with which nature in her most violent convulsions disturb the elements, are but faint and inconsiderable to those, that the high, proud, philosophical, and christianized European, brings into view, in the cruelties he inflicts on the simple, unoffending, and helpless African.

Blinded by avarice to the beauty of justice, mercy, and truth, various are the arts practised by Europeans, to obtain possession of the negro and make him a slave.[7] The principal method,

[7] *The former* methods adopted by Europeans, to obtain *possession* of the persons of the Africans, was to

however, taken to secure their persons, are those by which they obtain them through the agency of the corrupted African factors, or those in which absolute caption is made of their persons by force of arms. In the first instance, by means of bribes, they induce the king of one African tribe to make war on another which may be weaker. The instant a ship comes in sight, is the signal for a commencement of hostilities, war is begun, the unoffending tribe is immediately attacked, many are slain, their villages are set on fire, and the attacking party pick up the people as they attempt to escape from the flames, and considering them by the rights of war as prisoners, send them to the slave markets to be sold.

In these markets the slaves are found manacled, some chained to each other, and others

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make a sudden descent upon the coast, and after committing every depredation, to carry off the inhabitants. The natives of course soon fled from the coasts, to the interior parts of the country. The Europeans followed, entered their rivers, sailed up into the heart of their country, surprised them in their retreats, and dragged them off. The natives again fled, and as they had before abandoned the coasts, now abandoned the rivers, leaving the robbers without a prospect of their prey. The freebooters now adopted different measures, they built themselves forts, and settled in the country; where by means of bribes and other iniquitous practices, they soon corrupted even the Africans themselves, some of whom became their tools, and furnished them regular supplies of their wretched countrymen for slaves; thus when Europeans could no longer be thieves, they at last became receivers.

fastened to posts as our cattle are; and it is here that the most heart-rending scenes are witnessed: fathers separated from their children, mothers from their offspring. Husbands and wives are parted never to meet again; some are seen clinging to each other in the wildest transports of grief, separated only by the whip, or by the main force of their new purchasers, some are seen in a state of the wildest phrensy, and others seem by despair completely dead to even the horrors around them.

From the markets the slaves are driven to the sea coasts, and here those who survive the fatigues and hardships of the journey, are examined by European surgeons, both men and women, without the least distinction of modesty; those who are approved as good, are marked with *a red hot iron* bearing the ship's mark, after which they are put on board the vessels, the men being shackled with irons two and two together. On board the ships which are appointed to convey them to the plantations, their hardships are increased, from the great numbers each vessel is made to carry over; so crowded are the ships in general, that there is but barely room for the slaves to lay down, as not more than about three feet of space exists from the floor on which they lay to the ceiling or next deck of the ship; in some instances sufficient length has been denied them, and the poor creatures have been obliged to endure a long and tedious voyage laying on their backs with their legs bent, not having room *to stretch* their bodies to the natural length; in *this manner* one half usually die before the end

of the voyage. Driven to madness during the passage, by the severity of their misfortunes, or perhaps from illness, many refuse their food, in which cases an iron bar is made use of to wrench open their mouths, and to force it down their throats: while, through insanity, some dash their brains out against the beams of the vessel, and others throw themselves into the sea, many of whom when in the act of drowning, have been seen to wave the hand in triumph, exulting that they had escaped.[8]

When the ship arrives at its destined port, the wretched Africans are again exposed naked without any distinction of sexes, to the brutal examination of their purchasers; and here they are again sold to the planters, who take possession of them, and carry them in chains to their estates, where new sufferings commence.

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[8] Sometimes it happens, that in consequence of tempestuous weather, it is necessary that the ship should be lightened of her cargo: so lightly are the lives of the poor Africans then esteemed, that they are without any ceremony tied back to back and thrown into the sea. At other times, when the voyage is from adverse winds longer than usual, so as to make the provision scanty, it has been thought more profitable to drown them, than to run the hazard of their dying. In 1781, a hundred and twenty-two were thrown overboard from a vessel, although the ship had not been put upon short allowance. The wretched captain, on the trial of a law suit between the underwriters and the owners of this cargo, made this horrible excuse for his conduct, "that if the slaves who were *sickly had died a natural* death, the loss would *have been upon the owners*, but as they were all thrown *alive into the sea*, it would fall upon the underwriters.

The change of climate, (as the West Indies is much more unhealthy than the parts of Africa they are used to,) with the increase of labour, and the hardships that are imposed on them, together with the despondency of mind, which must necessarily attend those, torn for ever from their native land and kindred, usually have such an effect, that they drop and die in very great numbers.[9] Those who survive the first two years, are said to be seasoned, or fit to be put to a regular gang, to endure the further hardships and labours of slavery. When put regularly to work, they are sixteen hours every day, including the two intervals at meals, in the service of their cruel masters; and the shouts of the drivers, and the cracks of the whip on their naked bodies, which cuts out small pieces of flesh at almost every stroke, are heard all day long in the fields: when wearied with this, they are employed three hours more in making the necessary provision for themselves; five only remain for sleep, and their day is finished. During the time of crop, they are also obliged in their turns to work all night long in the boiling houses, which is a dreadful encroachment on their time of rest.

The greatest sufferings they endure, however,

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[9] Beside those that are slaughtered on the African shores, it is estimated that 100,000 are annually brought off from their native country; and, till the abolition of *the trade by* the British Parliament, two thirds of these *were brought* off by the ships of the English. 50,000 are *destroyed in* the voyage, and in the seasoning.

proceed from the brutality of their masters; for the slightest fault the slave is unmercifully beaten; often is he struck dead by a single blow, given in the moment of ungovernable fury; often is he scourged till his "spirit returns unto God who gave it." If the slave attempts to fly from these cruelties, a reward is set upon his head, his merciless pursuers overtake and shoot him, as they would a wild animal, and cutting off his head, exultingly bear it away reeking with blood, which they produce as the proof required by law to entitle them to the reward.

THE SLAVE TRADE.

(Continued.)

Ye who have hearts
As yet unsullied by the sinful stains
Of this base world; if, when the roving eye
Strays to the page where these unnumbered wrongs
Of Afric's sons are written down, ye feel
A glow of virtuous indignation fire
Your youthful breasts; or if ye drop the tear
Of sympathy and pity sweetly there,
Let not the world, when she comes on with all
Her joys, her pleasures, her deceits, her snares,
And her heart chilling *policy*, confound
These holy strugglings of great nature,—They
Are from the DEITY himself;—The God
Who made all mankind equal. Follow ever
The dictates of humanity; be led
By no vain sophistry: remember still,
To meet oppression both with heart and hand,
And shield the wretched from her spurn, and lift
The fallen from *her impious* tread.—Do this;
And though the shrinking body may decay,
And droop with the infirmity of age,
The heart will be by feelings like to these
Still kept for ever green.

CHAPTER V.

The Subject continued.—Abolition by the British Parliament.

Of all the atrocities, that from the earliest periods have unhumanized mankind, and called down the vengeance of an incensed God upon the world, the African Slave Trade is the worst, both in its principle and effect: for it is here that cruelty and fraud, oppression and avarice, lust and murder, tyranny, revenge, and every other horrible passion seem to meet in the human heart as in a focus; investing at once the Lord of the Creation, and image of the Creator, (as man is called) with all the attributes of a Demon. The African Slave Trade has the effect of making *this earth a hell* to one portion of mankind, and of preparing an other portion for the hell which lies beyond the grave.

So early as the year 1503, slaves were sent from the Portuguese settlements in Africa, to the Spanish colonies in America. In 1571, Ferdinand V. king of Spain, permitted them to be carried over in great numbers. The emperor Charles V. encouraged the Slave Trade, but in the year 1542, repenting of his former measures, he made a code of laws for their protection, and sent out orders, that all slaves in his American dominions should be made free; but on this emperor retiring from his throne into a monastery, slavery was resumed. About the same *time, Leo* X. pope of Rome, exerted himself, *much to* his honour, in behalf of the poor sufferers, and declared, "That not only the

Christian Religion, but that nature herself, cried out against a state of slavery." The first importation of slaves from Africa, in which Englishmen were concerned, was in the reign of Elizabeth, about the year 1562. This princess hearing that Hawkins had been engaged in carrying slaves, sent for him, and declared, "that were any of the negroes carried off without their free consent, it would be detestable, and call down the vengeance of heaven upon the undertakers."

In justice to England it may here be observed, that although her merchants were formerly the principal concerned in this abominable traffic of human kind, yet, from the earliest period, she has never failed in producing those, who, setting worldly policy at defiance, were ever ready to advocate the cause of the oppressed. Richard Baxter, Bishop Warburton, the poets Southern, Pope, Thomson, Shenstone, and Cowper, both in their writings, conversation, and public opinions, denounced the African Slave Trade, as a disgrace to human nature and a Christian community. But among all the advocates for the cause of African emancipation, the Society of Friends, or Quakers, as they are commonly called, have displayed the most unshrinking perseverance and faithful energy. As soon as the atrocities of slavery were made sufficiently known, these people liberated their slaves, whatever were the consequences, and some gave the most splendid *example in doing it*, by giving unconditional *liberty to all* their slaves, and by calculating

and giving what was due to them, over and above their food and clothing, for wages, from the beginning of their slavery, to the day when their liberation commenced.

In the year 1772, it was declared by the Judges, to the immortal honor of England, as a nation, that as soon as ever any slave set his foot on English territory he became free. From this time, the most active exertions were made by a number of benevolent individuals, for the total abolition of slavery: these persons formed themselves into a committee; while the indefatigable Clarkeson exerted himself to procure evidence of the atrocities connected with this abominable traffic; in this he so far succeeded, that in 1789, Mr. Wilberforce formally brought the question before the British Parliament. Misled by interested statements on the one hand, and by the machinations of those who were directly or indirectly gainers by the traffic of slaves on the other, the British Parliament were not so prompt as they might have been in their measures; in the interim, however, Clarkeson brought forward such a number of facts, relating to the cruelty, obduracy, tyranny, general guilt, and depravity, of those engaged in the trade, and procured so much evidence, although with immence difficulty, of the gentle and peaceable disposition, hospitality, and capacity of the negro, that in spite of two defeats in parliament, which occurred between the years 1794 and *1806, in 1807,* a bill for the total abolition of the *Slave Trade* passed through both Houses of *Parliament,* and received the Royal assent.

But although the legislature of our country, in this act, did much for the slave, it did not put an entire stop to the trade. Millions have since that time suffered all the cruelties and horrors of slavery. Other nations have brought the African from his native shores, and law and human nature have been violated again and again. At the present moment, the islands of the West Indies afford melancholy evidence of wretchedness and misery among the slaves; of poignant suffering and lingering distress. The negro is still a slave, he still writhes under the lash, and he is still debarred from those rights and privileges to which, as a child of one common Father, he is entitled.

It is truly afflicting to contemplate the sufferings of the negro; but it is ten times more so to think how far human atrocity can go, and what a demon man can become, when prompted by avarice and uninfluenced by religious principle. The history of the Slave Trade presents one of the finest lessons to mankind, and affords a moral to all the nations of the earth, and every succeeding age; fully impressing the reflecting mind with this severe but instructive truth, that the attainment of a high state of civilization, either in a nation or an individual, is not of *itself* sufficient to curb inordinate desire, or even to prevent the commission of the most horrible offences.

As a relief to the sad picture of human depravity which the Slave Trade presents, those who have from time to time stood forward endeavouring to succour the oppressed, "are as a shining light

that seems to be shining more and more int
perfect day." The condition of the slave is
considerably meliorated. But of all the
for benefitting the enslaved African, th
none so cheering and giving promise of so
future good, as that of establishing schoo
the education of the rising slave populatio
the principles of christianity, by the Mora
Bretheren and the Society of Friends. Deb
by the servility of his state to an almost fr
recklessness of the future, and having befor
eyes the ungovernable passions and horrid
of his enslaver, the negro is become degene
a victim to the worst crimes. Before, then
slave can enjoy civil liberty in its perfectio
must be restored to spiritual liberty; and
necessary that he should be delivered fro
tyranny of satan, before he becomes entirel
from the controlling influence and governme
man. The consolations of religion woul
themselves destroy the poignancy of sla
the knowledge of God and a Saviour, the b
ed influences of the Holy Spirit as a guide
comforter, and the hope that lies beyon
grave, are things so truly and vitally prec
that in witholding them for one moment th
a high degree of criminality, for with the
slave may still be happy, although surrou
by his tormentors.

There is every probability, that religiou
struction and gradual emancipation will go
in hand. Day after day, and year after
bring new advocates of this cause to the
and light seems to be more and more

among all nations. Man considered in the mass, is still encrusted with worldly considerations, and chained down to earth by human policy; but the day spring from on high hath visited him: let us hope that all these things will fall from him, like the scales from the eyes of the blind man, or as did the chains from the limbs of the apostle.

EUROPE.

Europa, Oh! Europa! blooming still,
Though iron hoofs have trampled on thy form,
And seas of blood deluged thy bosom. Thou
Dear hope of future ages, that containest
Promise of full perfection, and the germ
Of happiness for millions. Oh! I weep—
And has not human nature cause to weep?
To see what some call glory, bringing death,
Havoc, and devastation on the Earth:—
Thunders will rend the air, and lightnings cleave
The hardy granite with their forked fires;
The elements, storm, tempest, whirlwind, make
Man shudder,—but yet *man* can rise and wave
His mortal arm across the plain, and be
More terrible. The morning beam surveys
Ten thousand youthful eyes with ardor lit;
The stirring drum beats up hell-demon war,
The glowing day is red with carnage, and
The twilight closes over corses smear'd
With blood, and grinning enmity in death.
Oh! then, while blazing cities fill the dark
And pestilential night damp with their glare,
And sullenly the mournful trumpet sounds
Its short and hurried requiem o'er the slain;
What bitter groans and curses deep are breath'd
Amid its wailing cadences; what cries,

Deep moans, and lamentations then are borne
From orphan lips, and widows breaking hearts,
Upon the midnight's dewy breese to heaven.
How long, all righteous Father, wilt thou suffer
Thy mandates to be spurn'd, thy warnings scorn'd?
From year to year, from age to age, Thy law
And Thy commandment hath been peace; yet man
Still lasteth to destroy.—That daring chief
Whom war chose for her minion, calmly sleeps
Beyond the southern wave; but yet methinks
His spirit walks abroad, inciting men
To broil and tumult still. But it will come,
Thy kingdom yet will come: faint not ye few
Who live in prayer and supplication, for
The time when cruel war shall be no more;
The mighty God, the everlasting Lord,
The PRINCE OF PEACE, is faithful, just, and true;
The lion yet will covert with the lamb.

CHAPTER V.

OF EUROPE.

Europe, although the smallest quarter of the world, is the most famous for political power opulence, population, industry, genius of th inhabitants, cultivation of the arts and sciences and for every thing that adds to the comfort a convenience of man in a civilized state, or th tend to exalt him above the inferior parts of c ation.

From east to west, Europe is about 3,3 miles in length, from north to south about 2,3 and contains about 5,500,000 square miles. boundaries of Europe are, on the nort

Frozen Ocean,[1] on the west the Atlantic, on the south the Mediterranean Sea, and on the east lies Asia. The principal Seas are, the White Sea, in the north of Russia; the Baltic, surrounded by Sweden, Russia, and Germany; the North Sea, separating Denmark, &c. from England; the Irish Sea, between England and Ireland; the English Channel, between England and France; the Adriatic, separating Italy and Turkey; the Black Sea and Sea of Azof, through which runs the partition line dividing Europe from Asia.

The principal Gulphs are those of Finland, Bothnia in Sweeden, Venice, Riga, Dantzic, Lyons, Genoa, Tovento, and Salonica.

The principal Straits are those of Dover, Gibraltar, Messina, Gallipoli, Constantinople, and Kaffa.

The principal Lakes[2] are those of Onega, Ladoga, and Peypus, in Russia; Wener and Weter in Sweden; Neufchatal and Geneva, near France; and Lucerne, Constance, and Zurich, in Switzerland.

The Isthmuses[3] are those of Precops in the Crimea, and of Corinth between the Morea and Turkey.

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[1] An Ocean is a large collection of water, surrounding or washing the shores of a Continent: a Sea is a smaller collection, dividing different States, or running into the land; when, however, the quantity of water is but small it is called a Gulph, the narrow part of which is called a Strait.

[2] A Lake is a body of fresh water surrounded by land.

[3] *An Isthmus* is a narrow neck of land joining two *Continents, which* would else be separated by the Sea.

The chief Capes[4] are, in England, the La
End; in Ireland, Cape Clear; in Norway
Naze; in France, La Hogue; in Spain, C
gal and Finisterre; in Portugal, St. Vinc
in Italy, Sportivento; in Turkey, Cape Mata

The principal Islands[5] are, in the north, G
Britain, Ireland, Iceland, and Nova Zem
south, in the Mediterranean Sea, are found
norca, Majorca, and Ivica, belonging to Sp
Corsica, in the possession of France; Sard
a separate Kingdom; Sicily belongs to Na
and Malta, a place of great importance, t
English.

EUROPEAN STATES.

North are found Russia, Sweden and
way: Denmark, and the British Isles.

The central States are, Germany, compr
Austria, Hanover, Saxony, Wirtemberg,
Bavaria: France, Prussia, The Netherl
and Switzerland.

In the south lie Spain, Portugal, Italy,
key, Sardinia, and the Republic of the S
Islands.

Forms of government in Europe are abs
or despotic, monarchial, republican, or m

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[4] A Cape, or Promontory, is a high point o
stretching far into the Sea.

[5] An Island is a piece of land entirely surround
water. When a large piece of land is surround
water, except at one narrow part which joins it to a
Continent, it is called a Peninsula.

☞ For information respecting the Mountain
Rivers of Europe, with other miscellaneous matte
the Table.

An absolute or despotic government, is where the king is above the laws, of which Russia affords an instance. A strictly monarchial government is where the king rules according to established usages and customs; of course this will be different in different nations, and vary according to the genius of the people: in France the monarch's power is very limited; in Austria it has greater licence; in Spain it amounts almost to despotism. The constitution of England, consisting of an equitable balance of power, between the king, the nobles, and the people, is supposed to be the most perfect form of government that human ingenuity ever devised.

RUSSIA.

The Russian empire is the largest in the whole globe; it is greater than all Europe, but its population is very scanty, being not more than 50 millions, four fifths of whom are in a state of slavery, and of course immersed in the deepest ignorance. Before the time of Peter the Great, the inhabitants of Russia were little better than tribes of savages, but that enterprising sovereign, by his wisdom and indefatigable industry, raised his country from the depths of barbarism to take its stand among the civilized nations of the earth. Peter founded a city at the mouth of the Neva, called after him Petersburgh, which is now the capital of the empire; here also, he instituted an university and four academies, while in Moscow various places for the promotion of

learning were erected. Since the time of Peter, Russia has gone on progressively improving; the arts and manufactures have been gradually introduced, and learning and the sciences are silently making their way in spite of whatever is done to prevent them. During the reign of the late emperor Alexander, knowledge made rapid strides among the ranks of society; the higher classes patronized polite literature and the sciences; the middle ranks sought eagerly for information of all kinds, while the children of the poor were instructed in the elementary branches of education and religion, by means of Lancasterian schools, instituted at the expence of government, and under the particular patronage of the emperor. The present emperor Nicholas appears to be undecided as to what course he ought to pursue, in regard to the diffusion of knowledge among the people; on the one hand we find, that scientific and literary men receive considerable encouragement; yet it is scarcely two years since he prohibited lectures on philosophy from being delivered in any of the universities, and allowed the imperial academy of sciences to pass a regulation, prohibiting all the printers in the empire from publishing their books and memoranda, without express authority.

It cannot, however, be denied that Russia is making rapid progress towards civilization: her agricultural and commercial energies are brought daily into action; a spirit of independence and a desire for knowledge is manifested among the mass of the population, while the manners of more polished countries are continually adopt-

War alone can retard the progress of Russia. She is now pouring her hoards of soldiers into Turkey. It is impossible to look into futurity and foretel the event; but we know that "those that take to the sword shall perish with the sword."

FRANCE.

France is the great political rival of Great Britain, and is distinguished by the military prowess of its armies, and the volatile character of its inhabitants. In consequence of an unequal distribution of the taxes, from which the nobility and public functionaries were unjustly exempt, in the year 1789 the people rose in rebellion against the goverment, and massacred the greater part of the clergy and nobles. Louis, the king, in attempting to escape was taken prisoner, and afterwards beheaded. From this time the country had a republican form of government, and religion was nearly annihilated. In 1799, Napoleon Buonaparte, an obscure Corsican, but victorious French general, seized on the supreme power under the title of first consul, and in 1804 was crowned emperor of France and king of Italy. From this period to 1814 Europe was a continual scene of bloodshed, during which space of time Napoleon conquered nearly all Europe; but his grand army being destroyed by the severity of the frost in an expedition for the subjugation of Russia,

1812, two years afterwards he was obliged to retire to the island of Elba, under a treaty made at Fontainbleau. In 1815, Napoleon entered France, at the head of a few faithful followers, and in a few days was joined by the whole of the French army, and re-ascended the throne. The army of the allied sovereigns, however, under the command of Wellington and Blucher, meeting him at Waterloo, he sustained a complete defeat, and afterwards surrendering himself to England, was exiled to St. Helena, a barren rock in the southern ocean, where he died May the 5th. 1821, leaving the Bourbon family in quiet possession of the throne.

Louis XVIII. died in 1824, and was succeeded by his brother Charles X., whose first act was a wanton invasion of Spain, for the purpose of destroying its constitution. In 1825, a law was passed annexing the penalty of death to offences against the sacramental wafer, after which an attempt was made to put the publi press under restrictions, by a law being passe to that effect, which, if it had continued in ope ation, would have effectually arrested the pr gress of human knowledge, and soon brought the intellectual darkness of the middle ag The project, however, was after a while wis withdrawn Things at the present moment beginning to unfold cheering views to France delivered in some degree from that syste oppression and illiberal policy, which of late tinguished her, and education being now from ecclesiastical superintendance, intelli is making the most rapid progress. Sch

he Lancasterian system are every day encreasng, many of which teach science and mechanes, while M. Dupin, who may be considered a eal benefactor to France, loses no opportunity of exhibiting the facts and doctrines of science, in popular and attractive forms; the consequence of which is apparent in the general improvement visible in the manners of the populace, and in the products of the manufactures, which at the late annual exhibition excelled to a wonderful degree the specimens produced in former years. Agriculture is improving greatly: horticulture is a prominent object of enquiry; while, for the knowledge of medicine and practice of surgery, France is famous in every part of the world. The fine arts are no less flourishing, Charles having given them his patronage and support, and employed artists to adorn a part of the Louvre with paintings and other embellishments. Let us hope that this order of things will continue undisturbed by foreign broils or intestine commotions; and that France may speedily be delivered from her spiritual as well as her mental thraldom.

SWEDEN and NORWAY.

The Swedes are descended from the ancient Goths; and from the time that they embraced christianity, until the beginning of the fifteenth century, were subject to the regal power of Denmark; but Gustavus Vasa, one of their chiefs, delivered them from the Danish yoke, firmly established the Lutheran religion, and was placed upon the throne by the general voice of the people. In the beginning of the seventeenth century, Gustavus Adolphus became the defender of the Protestant Faith, and by his successful enterprises, prudence and moderation, exalted Sweden to a very high degree of political greatness, and rescued the Protestant Church from the authority and dominion of the Pope throughout all Germany. Christiana, his daughter, famed for her learning and talent for government, became a convert to that religion her father had opposed; and, abdicating the throne, spent the last days of her life in Rome. Charles XII. the most extravagantly heroic monarch that ever lived, after terrifying Europe with his enterprises, and astonishing the world by his individual prowess and personal bravery, brought himself to a premature end; and this horrid propensity for war and bloodshed had the effect to depopulate his country and bring it to the brink of ruin.

Napoleon Buonaparte placed Bernadotte on the throne of Sweden,[1] who endeavours by the

[1] *Sweden and* Norway, including Lapland, are under *the same monarch*, but Norway, owing to local cir*stances, and the obstacles* which nature presents,

spread of knowledge, and the encouragement of genius and learning, to obtain the love of his subjects. Sweden has produced many brilliant characters; the great Linnæus was a Swede, Berzelius, the discoverer of chemical proportions, and a very eminent writer on natural philosophy and mineralogy, is known in every country where science is encouraged, while Bishop Tegnér has produced poetry of a very high order. But the greatest proof of the wisdom of Bernadotte, and of the love he bears his subjects, is in the encouragement that he gives to societies for the promotion of education among the people: at the present moment there is scarcely a province in which the mutual or Lancasterian system of education has not been introduced; new societies are daily formed for the diffusion of useful knowledge, and premiums have been offered for the best new compilations of useful and entertaining matter, in a cheap form, fit to be introduced into the public schools. These measures are pregnant with very advantage to Sweden as a nation, and the motivation of amity with contemporary powers, and the blessings of peace will, under the Divine superintendence, produce happiness among all ranks of her population.

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and Sweden in civilization and commerce.—The inhabitants of the greater part of Norway subsist by farming and fishing. Norway nevertheless has produced eminent men; Krum Keyser in natural philosophy, Skjolderup as an anatomist, and Paul Moller as a moral and moral philosopher, rank very high, and will maintain their ground even in comparison with the literati of more distinguished nations.

DENMARK.

Denmark is one of the most ancient kingdoms in Europe, and was, a few centuries ago, one of the most powerful; various circumstances however, from time to time, have had the effect to prevent Denmark from rising to very great political eminence. In the beginning of the 17th. century, it was the object of Danish ambition to establish a formidable northern monarchy; the plan however was defeated. In the year 1660, the jealousy of the peasantry, in regard to the privileges of the nobility, induced them, for the foolish satisfaction of seeing that body humiliated, to give up many of their liberties, and in fact to succumb through the artifices of the monarch, to a form of government almost despotic.

Denmark, in the beginning of the present century, was a formidable competitor with England for naval glory; but in the year 1807 an English fleet was sent out, which nearly destroyed Copenhagen, and annihilated their shipping. This act of British policy, throws an indeliable stain upon the history of this country, as we had received no provocation, except of such a kind, as in the fable is laid to the charge of the lamb by the wolf. Denmark then may be considered in a state of decline; her commerce is trivial, her manufactures are of but little importance, and her finances are in a *deplorable state*; the chief source of her revenue, *the Sound* duties, being pledged for a loan,

contracted in London, in 1825. But there is one thing which renders Denmark the first nation in Europe, namely, her affection and devotion to her king.

Frederick VI. may be truly stiled the father of his people: equity seems to be his ruling principle; the prosperity and happiness of his people his sole aim: but by no way has this amiable man succeeded in gaining the affection of all classes, than by that parental regard he has ever manifested for the intellectual improvement of the poorer ranks of society. Adopting the British system of education, and supporting it by his patronage, purse, and individual exertion, Frederick has succeeded in organizing (as appears by a report made to his majesty in the beginning of the present year) no less than 2003 schools; and the effect has been most gratifying. The morals, behaviour, and general habits of the people, are improved in a most extraordinary degree; indeed, so convinced are the government that the measures of his majesty in this work will be productive of the greatest and most lasting benefits to Denmark, that preparations are now making to extend the mode of instruction to every village in the kingdom; and we doubt not, but that in a very short space of time, Denmark will stand a great and glorious illustration of the effects of universal education, which will compensate, in a very high degree, for her political decrease in the scale of nations, and her unavoidable calamities.

Iceland, *an island* in the northern ocean, *is subject to Denmark*; the inhabitants of which,

although not so polished as those of the mother country, are progressing in intellectual knowledge. Schools are becoming universal throughout the island.

KINGDOM OF

THE NETHERLANDS.

The Dutch are the most commercial and industrious people on the face of the globe, and have by their persevering and steady efforts, retained their place in the scale of nations, although they have shared all the troubles that have convulsed Europe, during the last thirty years, and partook of many political changes. The brother of Napoleon, (Louis Bonaparte,) was placed by that extraordinary man on the throne; but now, under the title of King of the Netherlands, their Stadtholder is restored, and the ten Belgic provinces, are again united to Holland. The paternal love of the King, (William I.) leads him continually to adopt such measures, as are likely to ensure the prosperity and happiness of his subjects. Commerce, the arts, and the manufacturies, are each improving; prison discipline, the establishment of schools, and of banks for the savings of the poor, are now beginning to produce their beneficial effects. The progress of education in the low countries, is more rapid than in any of the continental states; for no less than 633,859 children *are receiving* the benefits of daily instruction. *Mechanics* schools, in which the rudiments

mechanical philosophy are taught, are spreading over every part of the kingdom; and the king has recently granted ten pensions of 300 florins each, and ten of 150 to be dedicated to that number of females, with a view to their being employed as schoolmistresses: while every process that can facilitate the progress of the human mind, is resorted to; and publications in a cheap form on the elementary principles of the sciences, are daily issuing from the press. The Society of Public Utility, established in 1787, is the greatest national ornament of which the Dutch can boast. It has for its object, the diffusion of religion, morality, and useful knowledge among the poor, and adopts every measure likely to meliorate the condition, or improve the habits of the working classes. So popular has this society become, that it reckons at present, 170 sections in the kingdom, and two in the West Indies. Institutions at which the higher ranks imbibe human knowledge, are also numerous in Holland. In the kingdom of the low countries, six universities exist, and in the northern provinces, three Atheniums or superior colleges are established; and many societies and institutions for the prosecution of scientific studies, to which museums are attached, receive the countenance and patronage of the sovereign. Nor are the fine arts neglected, several establishments according to their various branches, are receiving the attention and support of a sovereign, whose sole desire seems to be to promote the best interests of his country.

GERMANY.

Germany comprises a great number of independent states, with the dominions of the emperor of Austria. The principal states of Germany are, Saxony, Bavaria, Wurtemburg, Hanover, &c. The dominions of the emperor of Austria are, Austria, Moravia, Bohemia, Hungary, part of Poland, the Tyrol, and Lombardy. The whole of these, with some less important states and free cities, unite in a political confederation, called the Germanic Confederation, the affairs of which are confided to a federative diet, at which Austria presides.

There is a marked difference between the spread of useful knowledge, and general education, in the free states of Germany, and in the Austrian dominions; in the former, we find a genial competition and emulation, that has the effect to disseminate knowledge among all classes; in the latter, the progress of the mind is checked by censorships and prohibitions. Among the free states, we find universities recently established; one at Munich in 1810, another at Berlin, in which all the branches of human learning are taught; while the schools are improved, and the instruction of the humble ranks of society, in the rudiments of education and in religion, is the first object of the constituted authorities. In the Austrian dominions, the very reverse of this is noticed. All *the schools* and colleges are under the immediate superintendance of government offic

ıile the studies of the pupils are regulated by e priests, who, by their rigid enforcement of tholic discipline, seem to wish to produce a neral state of intellectual and moral torpor. ıus then do ignorance, superstition, and de- otic power, combine to produce mental dark- ss and political degradation. Happy indeed e they, who live in a land where they can joy mental, political, and religious freedom.

PRUSSIA.

Prussia, one of the states belonging to the ermanic confederation, is a very considerable ıpire, parts of Poland and Saxony being now ınexed to it. It is divided into Royal Prussia, ing on the west of the Vistula; and Ducal russia, lying on the east of that river. Prussia ay be said to be making gradual advances wards civilization. During the last fifteen ars, many extensive seminaries for the culti- ıtion of the sciences have been instituted. The ıiversity of Berlin, founded in 1810, is one of e most extensive scientific and literary esta- ishments existing on the continent, being at- nded by about 1,500 students. The king of russia seems to be anxious to advance science every way, compatible with the genius and ıtional predilections of the people. He is *mself fond of* the society of men of high sci- *ific and literary* attainments. The distin-

guished Humboldt and others are in his confidence and esteem, which may be hailed as a favourable indication of the monarch's future attention to the intellectual progress of the country.

SPAIN.

The philanthrophist when he directs his eyes towards Spain, weeps at the wretchedness, degredation, and intellectual darkness by which she is distinguished. Despotism and ecclesiastical influence, illiberal policy, military occupation, and the perfidy of the king, render Spain the most debased and miserable of european states. The arts and sciences, education, literature, all are dormant. The mass of the people are precluded from every source of information; all books, particularly foreign works and the English journals are prohibited, and the only literary productions of importance which have recently appeared, are the Statistical Dictionary of Spain and Portugal, by D. Mignaus, and the Biographical Dictionary, in which the king is anxious that notices of all the Spanish worthies shall appear; as if wishing to throw round his benighted and prostrate kingdom, a halo of her former glory.

PORTUGAL.

Since the year 1807, the government of Portugal has undergone many important changes. In that year the king, (John VI.) embarked for the Brazils, leaving the government in the hands of a regency. The power of this regency being gradually weakened, and a revolutionary spirit manifesting itself among the people in 1820, (the year of the Spanish revolution,) the king was advised by his minister, Count Palmella, to send his son to Portugal, with a constitutional charter. While meditating on the best measures to be pursued, a revolution broke out in Brazil: the king immediately adopted the constitution of the Brazilians, and set sail for Portugal, leaving Don Pedro as viceroy in Brazil. The revolutionary cortes, however, demanded the return of Don Pedro to Portugal, but the Brazilians insisting that he should assume the crown of Brazil, Don Pedro, after several remonstrances from his brother, acceded to the wish of the Brazilians, and, in the end, proclaimed the independence of the Brazilian empire. In 1823, the occupation of Spain by the French army, in order to replace Ferdinand in absolute power, induced a faction, with Don Miguel at their head, to attempt a counter revolution; the king, however, proclaimed a free government, and ordered a constitutional junta, to draw up a charter of rights and privileges; but he soon after was compelled to restore the ancient monarchy. On the 10th. of March, 1826, king

John VI. died at Lisbon, leaving the k
under the government of a regency. Don
the emperor of Brazil, immediately repa
Portugal, issued a constitutional chart
confirmed the regency appointed by his
On the 30th. of October, 1826, the infa
Miguel, took the oath to the charter, a
betrothed to Donna Maria, the young
Soon after this a party influenced by th
mother, induced considerable bodies
troops to rise in rebellion against the
vernment, while Spain secretly aided and
the insurrection. Great Britain, howev
out ten thousand troops to restore tran
and defend Portugal against the inva
Spain. After several skirmishes betw
constitutional troops and the rebels, th
were entirely defeated, and the peace of P
was almost completely secured. In
scheme was devised by the queen moth
supported by the courts of Spain and
for investing Don Miguel with the reg
the empire. Don Pedro also sanctio
plan, but endeavoured to make a provi
the chartered rights of the people should
entire. In December last, Don Miguel
in London, making professions and p
respecting the constitution; but on his r
adopted an absolute form of governmen
young queen Donna Maria has since t
fuge in this country.

In a country thus distracted by i broils, it can scarcely be expected, that *or the sciences* should make much

There are scarcely any institutions favourable to the emancipation of the human mind, from that bigotry, blindness, and superstition which environs it, in this unhappy country; consequently the higher ranks are in that intellectual torpor, that produces a general paralysis of commercial pursuits, while the lower ranks are in the most wretched state of moral depravity. A free constitution, with a deliverance from popish authority and council, is indispensable to the intellectual and political existence of Portugal.

SWITZERLAND.

Switzerland is divided into twenty-two cantons, and is remarkable for the romantic nature of its scenery, its mountains, and the spirit, simplicity, genius, and persevering industry of its inhabitants. Some of the Swiss cantons are protestant, others catholic: the political principles of each are also widely different, being not unfrequently opposed to each other. There is also a marked difference in degree of civilization; the protestant cantons exceeding the catholic very remarkably. In the protestant cantons, a very lively interest is taken in the progress of education; and the organization and management of various kinds of schools, form a principal character in the public measures. Schools of arts, mechanics schools, and those for the teaching of the rudiments, are every day increasing. In the catholic cantons, the schools are by no means so numerous, and the Jesuit

have begun to exercise a very dangerous
over those that do exist. In those canto
find fifty-nine monasteries, sixty-one nunn
and seven hospitals for capuchins. Upo
whole, Switzerland may be said to be
gressing in the intellectual scale, and ke
pace with the spirit of the times.

ITALY.[2]

Italy, the parent of the arts and sciences
the mighty focus from which Roman glory
her rays to almost every part of the worl
hibits at the present moment a proof of th
rishable quality of worldly greatness; and
amidst broken columns, ivy-grown arches
ing aqueducts, and decaying temples, m
said to give a solemn warning to mankind.
shores of Italy are still luxuriantly fertil
that is delicate and beautiful, mingling ever
desolation. The brightest creations of h
genius are, indeed, in the dust; yet nature t
around them, from year to year, the vernal
som, as inconsolable for the loss of her fav
children, and anxious to deck the grave o
beloved ones.

The principal trade of this fine country i
in the relicts of her former glory; yet the
merce of Italy is considerable, owing t

[2] Italy is subdivided into six States; the Pop
minions,—the King of Sardinia's dominions,—the
dom of Naples,—Lombardy and Venice,—and
government of Austria, with Parma and Tuscan

great fertility of her shores. The fine arts, painting, sculpture, music, and poetry, are more universally cultivated than the soil, or even the human mind, for in Italy we find ignorance and its consequent adjunct, crime, prevailing to a very grevious extent; and paradoxical as it may appear, the worst of vices predominate where the highest degree of refinement is fonnd; for alas, instead of the spirit of religion, Italy has but the form,—they ask for bread and receive a stone. Many bright geniuses have nevertheless recently appeared in the various departments of literature and science; the names of Volta, Timburina, and Ugo Foscolo, will not be soon forgotten. The arts and literature in many of the states are making considerable progress, but the moral and religious education of the mass of the people is neglected, schools of mutual instruction being prohibited, which illiberal policy must, while it continues, have the effect to keep the country in its present degraded and demoralized condition.

TURKEY and GREECE,

Were once the seat of learning and the arts, and produced the greatest geniuses, statesmen, warriors, and philosophers that ever existed; but are now the theatre of war, bloodshed, and *massacre. In the* commencement of the *christian era, these* celebrated countries fell unde

the dominion of the Romans, and passed from them into the hands of the Turks, who conquered Constantinople A. D. 1453.

The modern history of this fine but unfortunate country, is a continued picture of the arrogance and cruelties of the enslaver, and the miseries of the enslaved. The commencement, indeed, of the present century, exhibited Greece in an improving state: relieved from some of the more overwhelming imposts to which they were subjected by the Turks, the commerce of Greece was increasing very rapidly. Selim III. granted the Greeks new commercial privileges, and formed a body of merchants, under the title of "privileged merchants," which had the effect to increase their trade and bring considerable wealth into the country. The daily extension of Greek commerce had of course a powerful influence upon the intellectual progress of all classes; much useful information was daily extracted from the more intelligent european states, and the comforts and refinements of society were daily spreading through the mass of the population; while literature advanced in a comparitive ratio, and schools and colleges and literary societies were established in various places; the mists of ignorance were clearing away; the heroes of other days arose to the intellectual eye; the energy of their ancient sires was renewed: Greece panted to be free.

The endeavour to throw off the Turkish *yoke, brought* to the fertile shores of Greece *all the horrors* and disasters of war. For seve *years have* an enlightened and valiant peop

been fighting for their liberties, and defending themselves against the oppressor. The allied powers have made many fruitless endeavours towards a pacification and arrangement, by which the Greeks might be delivered from their distresses, but the Porte has turned a deaf ear to every thing for the advantage of the oppressed. Wishing to use some decisive measures, in October, 1827, the British, French, and Russian, fleets entered the port of Navarin, where the whole Turkish fleet was at anchor, and in consequence of some of the crew of one of the Turkish fire ships firing on a boat sent out to them, a battle took place, and the complete destruction of the whole of the Turkish fleet was the consequence.

Since this affair, Russia has declared war against Turkey, and entered her territory, where success seems to attend the invading army; Varna, a place of great importance, having recently fallen into their hands. There is little doubt but that the war will end to the advantage of Russia, and that the Greeks will ultimately be delivered from the oppression of the Turks: when this is effected, it appears probable that Greece will re-imbibe some of her former glory.

There is no country in the world in which nature is more lavish in her favours, nor where the enterprising merchant could with more advantage settle, than in Greece, when delivered from the despotic sway of the Ottoman; her local situation being such as to render her, under a free government, capable of becoming a distinguished *maritime* as well as a commercial nation.

GREAT BRITAIN.

Alone in calm and passionless majesty
Britannia stands.——Tumults have shook the earth
Convulsions terrible, strife, faction, war,
Throbb'd thro' the pulse of nations;—Kings have been
Mere puppets for the sport of tyranny;
Empires but poor and paltry baubles, which
A giant mind trod on disdainfully,
Lifting his head above the stars,—But Thou,
High favoured England, Thou stand'st calmly still,
Unhurt, unblemished, undisturbed, unmoved,
And unsubdued.——What in the hour of death,
When the red war was raging round thy shores,
Preserved thee all entire, unnerved the arm
That strove to lay thy freedom in the dust,
And gave thee victory's triumphant wing
To flutter 'bove the thunder:—Was it strength
Of mortal flesh?—Was it the puny arm
Of feeble man?—Was it the marshall'd host,
The flashing steel, or the dread cannons' rage?
No! 'twas the Lord, the mighty King of Kings,
The everlasting God.——Then ye that stand
Foremost and forward in your country's fame,
And rule her destinies beneath the eye
Of her eternal Guardian; if ye feel
That He is all in all, and that the fate
Of kings and empires centre in his will;
Look on the perishing multitudes, that in
Chaotic darkness, and the stubborn chains
Of mental thraldom, grasp their devious way
Unto the desolate grave, with scarce a ray
Of light divine to guide and cheer their steps.
Oh! lift them unto Him; awake them; strike
Fire from their hearts, not such as trampling hoofs
Strike from rude stone, but such a fire of love
As gospel precept will engender there,
To spring exulting unto heaven, and draw
The blessing of the everlasting down.

ands at the head of all nations, for the extent her foreign possessions, her wealth, com-erce, political power, and the wonderful pro-ce of her manufactories;[3] and although in me degree under pecuniary embarrassments, consequence of a protracted and expensive r, she is, nevertheless, rapidly advancing vards a high pitch of refinement. In Eng-d, not only the comforts and conveniens of life are to be found in abundance, but st of those elegancies and luxuries, which e proofs of national prosperity, are spreading ong all ranks in profusion. London, (now taining 1,270,000 inhabitants) is so greatly proved within the last ten years, by new streets, blic edifices, &c., as to yield to no city on the be for architectural grandeur; while the va-us new establishments for the prosecution of entific knowledge, and societies for the en-uragement of the arts, are throwing their be-n influence to every part of the empire, at the ne time learning is daily receiving some fresh petus, by the establishment of new institutions,

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[3] The chief manufacturing towns and cities in Eng-d are, Birmingham, remarkable for the variety and uty of its articles; Sheffield, famed for its cutlery e; Manchester is celebrated for its cotton manu-ories, and Nottingham for the weaving of cotton kings.

The English manufactories were recently estimated the annual value of £93 millions, and are supposed employ a million and a half of her population.

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[3] The chief manufacturing towns and cities in England are, Birmingham, remarkable for the variety and beauty of its articles; Sheffield, famed for its cutlery ware; Manchester is celebrated for its cotton manufactories, and Nottingham for the weaving of cotton stockings.

The English manufactories were recently estimated at the *annual value* of £63 millions, and are supposed *to employ a million* and a half of her population.

among which may be numbered the New London University, and King's College, which in consequence of the munificence of public support, are erected upon a scale of the most extensive usefulness and highest magnificence. The limits of this work will not allow us to enter upon the numerous resources of this highly favoured kingdom; we therefore subjoin a sketch of the British Constitution, which from its recognition of civil and religious liberty, among all ranks, has in no small degree tended to the exaltation and prosperity of the British empire.

The British Constitution.

——— Glorious monument,
Of all that patriot hearts should struggle for;
Cemented by the blood of heroes, chiefs,
And the bold worthies of the olden time,
Radient with liberty's bright beam. For thee,
Proud trophy of a nation's highest pride,
A Hampden perished, and a Russel bled;
And thousands struggled in the mental night
That wrapt all nations lit by the cheering ray
Of freedom, which unto the eye of faith
Seemed dawning on the land. Oh! ye that fell
Before the haughty Norman's thirsty steel—
Your weapons in your hands,—and ye that stood
At Runnemede, cased up in burnished mail,
To gain the charter of our lands and lives:
Ye godly pleaid, who in heaven's name
Implored the tyrant on the bended knee;
And ye that fell on Chalgrove's bloody field,—
We owe ye much: ourselves, our children, owe
A debt of gratitude, increasing with

The glorious progress of the deathless mind
Each passing year. Oh! if your spirits watch
O'er England's weal, and can forgive the scoffs
Of those more base than regal tyrants—if
Ye smile on those who would uphold the cause
For which ye struggled—teach us to transmit,
Pure and entire unto our children, all
Those glorious rights to which ourselves were born.
And be Thou with us, never failing God;
Throw round us thy protecting arm,—endue
Thy servants with the holiness, the faith,
The union, and peace; to serve, to love,
And trust in Thee—in Thee alone,—to save,
Through ages yet to come, from storm and wreck
The people and their king.

CHAPTER II.

Of all the monuments of human wisdom and prudence, which history presents to us in connection with the government of nations, the British Constitution is the most transcendant; for viewing it in whatever light we may, we see besides that inherent sagacity of the human mind, which is always apt and ready to take advantage of events for the assertion of its natural rights, the energies, the struggles, and the devotion of a high minded, brave, and generous people, concentrated in one almost perfect form of government.

From the experience of past ages, our forefathers found in opposition to a general maxim, that "the simplest things are the best," that those *simple forms of government*, which are termed *democratic, aristocratical*, or despotic, had each

of them very formidable defects. Democratic forms of government, have ever been remarkable for rashness, indecision, and the turbulence of faction; although perhaps very honest in their views, and public spirited in their decisions. Aristocratical governments, although having many advantages, are apt to become soon corrupt; while the ambition and intrigue of those whose interests are opposed to each other, often plunge a country into all the horrors of a civil war. An absolute monarchy is doubtless in certain exigences indispensable, but monarchs like all other men, are subject to passions and prejudices, and where weakness be joined to an impetuous mind, which is frequently the case, the best interests of the community are often sacrificed to caprice and whim. Now the British Constitution is a mixture of these three forms of government, in which all the advantages of each are preserved, and the evils and inconveniences are rejected; "for," to quote the sentiments of Justice Blackstone, "as with us the executive power of the laws is lodged in a single person, they have all the advantages of strength and dispatch, to be found in the most absolute monarchy; and as the legislature of the kingdom is entrusted to three distinct powers, entirely independent of each other; first, the king; secondly, the lords spiritual and temporal, which is an aristocratical assembly of persons, selected for their piety, their birth, their wisdom, their valour, *or their* property; and thirdly, the House of *Commons* freely chosen by the people from *among themselves*, which makes it a kind of de-

mocracy; as this aggregate body actuated by different springs, and attentive to different interests, composes the British Parliament, and has the supreme disposal of every thing; there can no inconvenience be attempted by either of these three branches, but will be withstood by one of the other two; each branch being armed with a negative power, sufficient to repel any innovation which it shall think inexpedient or dangerous."

It will not be supposed that a form of government so perfect as that of England, was hastily conceived or was the result of a single effort of mind, or was the production of one age. The history of the British Constitution, begins about the time the Saxons held dominion in England, and is strictly speaking of Saxon origin. In the councils often summoned by the several kings of the Heptarchy, from among those of their subjects, the most eminent for bravery, wealth, or influence, may be traced, the first faint outline of the excellent form of government we enjoy.

William the Conqueror introduced the feudal system, and he and his successors, endeavoured to efface from the minds of the people, the Saxon Constitution, at which period the peasantry were in a state little short of slavery, and although charters were from time to time granted by Henry I. and Stephen, yet they were only given under peculiar exigences, and consequently never faithfully adhered to. However, in the reign of John, those classes of persons, among whom intelligence had made any advances, became the adherents of the Barons, who with their swords

in their hands, demanded and obtained from that monarch, "Magna Charter," the great charter of English liberties, which was confirmed by Henry III. his son and successor.

From the time of John, the people began to comprehend better their political relationships; a silent but gradual emancipation made its way, and the power of the monarch became daily abridged; nevertheless, the authority of the crown during the reign of Henry VIII. was of an almost overwhelming influence, partly from the accession of ecclesiastical wealth, which fell to that monarch upon his annulling the supremacy of the Pope, and declaring himself the head of the English Church; and partly from the pusillanimous and unspirited conduct of the people. After the death of Henry, the royal prerogative was narrowly watched, and although Elizabeth was excessively jealous of her privileges, and James I. imbibed the highest notions of the kingly prerogative, entertained by the most tyrannical of his predecessors, yet the power of the people became gradually more and more extended, and that of the monarch more limited. Charles I. by an unlimited extention of the royal prerogative, and by arbitrary and violent methods of raising money, brought his kingdom into a civil war, and ultimately lost his head on the scaffold. The reins of government now fell into the hands of some gangs of fanatical democrats, whose wild and contradictory measures, terminated in the *unlimited* despotism of Oliver Cromwell.

Charles II. carried his measures in the most *arbitrary* way, and James II. to the qualities of

a despot, added those of a bigot, which led to his expulsion from the throne, and the accession of William, Prince of Orange, to whom the celebrated Bill of Rights was presented, which guaranteed the liberty of the subject, and set proper bounds to the royal prerogative. The principle items of this bill are, that "the pretended power of suspending laws or the execution of laws by royal authority, without the consent of parliament is illegal, that the freedom of speech and debates and proceedings in parliament, ought not to be impeached or questioned in any court or place out of parliament; and that the raising or keeping of a standing army within the kingdom in time of peace, unless it be with the consent of parliament, is against law." The Bill of Rights may be considered as the palladium of British Liberties, as it is founded upon the great principles of public justice and the law of equity, and asserts those high privileges of the people, which are to be collected from the practice of the best times.

The legislative power in England is lodged in three different branches, which must all concur in every act of legislature; these branches are, first, the King—second, the Lords of Parliament—third, the Commons or Representatives of the people. Each of these branches has certain rights, those of the King are called prerogatives, those of the people are styled privileges.

THE KING.

The title of King belongs to that person, who by right of succession is invested with the supreme executive power in these realms, the right of succession to the throne, being by the established law of the land, hereditary; consequently a female when nearest in lineal descent, is allowed to govern, under the title of Queen, provided she subscribes to the forms and conditions, prescribed by the constitution.

The King is the fountain of justice and mercy,[3] he is also the fountain of honour, for from him are derived all the various degrees of nobility; he is arbiter of commerce, regulating weights, measures, and the public coinage of the realm; he is the supreme head of the Established Church, and can preach and administer the sacrament; he is the supreme judge in every court of law, and chief of the naval and military power of the kingdom.

As the chief magistrate of the state, the King possessses the sole power of declaring war, or

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[3] It is the King's privilege to pardon, but not to condemn, neither in his own person nor in the persons of those to whom he delegates his authority, (the Judges); for it is the birthright of every Englishman, that upon his being charged with any offence, either against the state or an individual, that he shall be judged by a jury, consisting of 12 men, who shall be his peers or equals, and who must be unanimous in their verdict of guilt or *acquittal.*

The Judges are appointed for life, and not at the *pleasure of the* King; to prevent any undue influence *which might* be exercised by his authority.

making peace; of appointing ambassadors, and of receiving those of foreign potentates at his court; it is his prerogative to enter into treaties and to form alliances with foreign states; of assembling, proroguing, and dissolving the parliament, and of giving his assent to such new laws as he apprehends will be for the good of his subjects.

At his coronation the King binds himself by a solemn oath, in the presence of his subjects, to support the Protestant religion as by law established, to observe the great charter of the English liberties, to pay obedience to the laws, to govern his people according to them, and to execute judgment in mercy. The person of the King is held sacred, and it is said that "he can do no wrong."[1]

THE LORDS.

The House of Peers is composed of the Lords spiritual and the Lords temporal; the former consist of two Arch-bishops and twenty-four Bishops, and of four Bishops taken by rotation

[1] Strange as this maxim may appear, it is a sacred principle in our constitutional law, that for all the public acts of the King his ministers are alone responsible; in other countries the odium of obnoxious measures falls upon royalty, and when public discontent runs high the sacred person is endangered; but the English government allows, that when certain measures are disliked by the people, *and the public acts are unpopular, the King to change his ministers*, and to select others more in the *confidence of the people.*

from the eighteen Bishops of Ireland; the latter includes the Princes of the blood royal, with the whole of the hereditary English nobility. The number of the temporal Peers is *unlimited* with regard to England; but the Scotch are allowed to send but sixteen Peers to parliament, who are elected by their own body for one parliament only: Ireland is allowed to send twenty-eight Peers to parliament, who retain their seats during life; each vacancy by death is filled up by a new election. The privileges of the Lords are, voting by proxy, the franking of letters, a right to negative in all legislative proposals, of entering on the journals of the house a protest against any measures adopted by the majority, with their reasons for dissent. The Lords are free from all arrests of debt. In criminal cases they are tried only by their Peers, who give in their verdict not upon oath as other juries, but only upon their honour.[s]

THE COMMONS

Are the representatives of the people, and returned to serve in parliament by the votes of all persons possessing a freehold estate of the value of forty shillings or upwards per annum, situate in the county for which the elector claims a vote.

[s] To secure the honour and prevent the spread of any scandal against Peers by reports, there is an express *law, called* Scandalum Magnatum, by which any man *convicted of* that crime, although the report be true, is *condemned to* an arbitrary fine, and to remain in prison *till the fine* be paid.

The House of Commons consists of 658 members, 80 of which represent the 40 counties of England, 339 the boroughs, 50 the cities, 16 the cinque ports, and two for each of the universities. Wales sends 24 members, Scotland 45, and Ireland 100.

The counties are represented by knights of the shire, who must possess an estate in freehold or copyhold of the value of £600. per annum. The cities are represented by citizens possessing an estate of £300. per year, elected according to the charter or custom of the city. The boroughs are represented by burgesses possessing also an estate worth £300. per year, elected according to the particular franchises of the voters.

The privileges of the Commons are, the right of speech, and of passing a negative on all laws proposed to them, access to the King, franking of letters, and the right of originating all money bills; that is to say, of taxing themselves and the nation. They are also empowered to search into the conduct of even the highest peer of the realm; to call the judges to account for the mal-administration of their office; they can impeach the prime minister, and they have authority to procure redress for all national grievances.

The parliament or whole legislative body united, possesses unlimited power, and is in fact absolute, there being no authority legal that is not derived from it.

We have here then what is called the British Constitution, which is without question the most *perfect form of* government that human ingenuity

ever devised; each part of it being perfectly free in itself, according to the established rules of equity, at the same time that it is dependant upon the others; the liberties of all being alike strongly secured; the sovereign has whatever is necessary to secure to him the respect and obedience of the people; the nobility are invested with all the privileges necessary to maintain their rank with splendour, and to keep up the honour of their families; while the Commons, having alone the right of taxation, can at any time put an effectual stop to lawless extravagance or improvident enterprise; for although the King may raise what force he pleases, the Commons can determine what number he shall pay; as they can at any time withhold the supplies, and thus paralize the strength of the other two estates. But as a counterpoise to this power, the King is invested with another, the power of dissolving the parliament, whenever it is manifest that the Commons are actuated by factious motives; and then by submitting their conduct to the revision of their constituents, to appeal against them to the body of the nation. Independent of these three estates, the people at large have a right to hold meetings for the expression of public opinion, and to petition the parliament at all times for a redress of grievances; all that is required for the perpetuity of this glorious creation of our forefathers, is that the people themselves should be honest; and by choosing such for their representatives, whose *wisdom is capable* of managing public affairs, *whose virtue* render them devoted to their coun-

try, and whose religion teaches them to shun corruption, and to suffer themselves to be led by that high and holy principle, which would render every action worthy of register in the archives of the eternal; affords the greatest extent of civil and religious liberty which ever was enjoyed by any country on earth. Such then is the British Constitution,—a Constitution which has raised England to be at once the most powerful, the most illustrious, the most wealthy, and most happy country upon the face of the globe; and made her first in the scale of earthly grandeur, and the envy and admiration of surrounding nations.

THE

Education of the British Population

CONSIDERED.

CHAPTER III.

In turning from the monuments of national grandeur, and from the luxuries and wealth that abound in this flourishing country, to the homes and places of resort of that class of people, whose industry is mainly instrumental in producing them, the philanthropist is induced to drop a tear, at the intellectual, and more particularly at the moral degradation that prevails on every side.

To a *mind unacquainted with the various springs of action which influence*, and not regulate, the

involved machinery of civilized society; the intellectual and moral state of England at the present moment, compared with the dignified attitude that she holds among the nations of the earth, or with her abundant riches and unfailing resources, seems to present a perfect anomaly. The eye that takes but a superficial view, surveys trophies of national superiority, or monuments of the most refined elegance, public buildings in all the chastity of attic grandeur or the elaborate detail of Saxon magnificence, and temples devoted to the service of the living God, are springing up before the beholder which ever way he turns; while institutions that rise from a national morality, surround us, for the relief of almost every infirmity, accident, or vicissitude to which human nature is subject: the deaf, the blind, the lame, the sick, meet on every hand with an asylum; the helpless are provided with assistance, the outcast with a home: even vice has her institutions,—the juvenile delinquent and the old offender receive the labours of the benevolent; and the female wanderer from the paths of virtue, finds pity, consolation, and protection: but in the midst of all these sublime spectacles of true greatness, which are as stupendous in the moral world as the "heaven kissing" Andes in the natural, vice may be seen like the spectre of the Broken, rising up from the mists of ignorance and error, in terrific effrontery and truly colossial dimensions, threatning all the civil compacts of society, and *every law*, human and divine.

It may with truth be affirmed, that the lower classes in many parts of England, are in a greater state of moral depravity than those of most parts of Europe: for to enter into detail, we find intoxication, idleness, profane conduct, swearing, a general disregard for religion, and the excessive indulgence of low and animal sensuality, to be prevalent among the manufacturing classes; while among the peasantry, a ruffian-like austerity of behaviour, a savage ferocity in manners, a delight in cruelty, and a reckless insubordination of spirit, may be superadded: thus England at the present moment, presents a picture over which the philanthrophist must grieve, and the legislator almost despair; for while it continues, all the efforts of the benevolent will avail them nothing, and the laws will fall powerless in execution.

Such a fearful state of things cannot be attributed to a general disregard of the rich for the poor, for active benevolence was never more prevalent; nor to the demoralizing effect of national poverty, for England stands at the head of all nations for wealth;[1] nor can it be from the want of public instructors on religion, or

[1] It will not here be inferred that poverty and wretchedness do not exist among the poor, or that they do not in a great measure produce crime. It must be, however, recollected that even this makes education the more indispensable, and adds another argument in its favour, for we know that the legislature *cannot* relieve the bodily wants of the people to any extent, but we are sure that religion will soften the rigours of the *severest hardships*, and subdue the bitterest repinings of *the spirit*.

faithful stewards of God's word, for such are more numerous than can be credited. To what then is the primitive cause of these distresses to be attributed?—To the want of the early offering of the heart to God, and those religious impressions upon the minds of youth, which should grow with their growth and strengthen with their strength,—to the want of that subordination which school discipline so well enforces, and to the want of a due cultivation of a virtuous abhorrence of evil, which springs from a mind brought up in the nurture and admonition of the Lord;—in one word—to the want of a more extended religious education among the mass of the British population, may be attributed all the discrepances of moral government, which good men seek to remedy and all men deplore.

It may appear to those who take a casual view of this question, that institutions for the education of the people, have kept pace with the other institutions of the age; but upon calculation they will find the contrary to be the case, and that education has by no means been persisted in, to anything like the extent that would ensure a reform of habits and manners among the people: in the first place, it may be observed, that not one fifth part of the money has been raised for the cause of education, that has for the printing and distribution of bibles; besides it must be taken into the scale, in the comparison of this with other benevolent institutions, that *but a limited* number, through the infirmity and *disease of the body*, or the inevitable vicissitudes *of life require* the aid of the benevolent; whereas

all, without exception, require education; thus, were the means ten thousand times greater than they are, it is to be feared that even then a very large number would be left perishing for the lack of knowledge.

The reason education has been thus shamefully neglected, is from a notion among those who alone can extend its benefits, that the rays of truth, like those of the sun, if too abundant, dazzle the multitude rather than enlighten them; but the analogy is false, inasmuch, as although truth is brighter than the sun, yet the mind is stronger than the body, and the intellectual eye can look at the essence of moral truth with a power of vision increasing with the brightness that shines upon it. The effects of general scriptural illumination will be, beside the spread of sound morality, the emancipation of the minds of the people from the baneful influence of designing men or fanatic sectarists: for ignorance may be said like the German student, to set up a destroying monster in the place of humanity; but the enlightened mind, like the artist who restored the Medician goddess, can associate and put together the scattered fragments of moral truth, re-producing divine beauty and perfection at will, although they have passed to it through the darkness of many ages, and in a thousand pieces.

It is difficult to refer to the effect of national education upon mankind at former periods, and it would be not only absurd but profane to compare it with the probable effect of a general diffusion of religious knowledge, and the cultivation of christian virtue and moral discipline. We hav

enough upon record to convince all profess
ing the christian name of its necessity an
value, for the eternal mind has declared its in
dispensability from time to time, by the mouth
of his prophets and his saints; and it was no
only a part of the redeemer's ministry and offic
upon earth, but may be said to be included i
his last injuntion to his disciples.

Education must then be considered not only a
a valuable accession to the mental energies o
a people, or as a political machine that may b
made subservient to the best interests of society
but as an indispensable auxiliary to religion, an
one of the most efficient engines for promotin
Christ's kingdom upon earth, that has appeare
since the preaching of the apostles.

An uneducated population adds to that dea
weight which hangs upon all governments, an
the minds of a people but slightly illuminated b
the sun of knowledge, like the partially froze
rivers of Siberia, are unfit for the purposes
common intercourse, and become a disadvan
age to a nation rather than a blessing. A ma
of stagnant intellect may be deluded by eve
petty democrat that chooses to turn orator,
overpowered by every crafty fanatic that
the temerity to take upon himself the sa
function; as witness the oratorical influence
spiritual ascendancy of the Puritans over
people, during the troubles that characte
the reign of Charles I. But an enligh
population will be satisfied only with sou
duction and right reason in secular thin
with sound doctrine and practical prece

clesiastical ones; consequently it will not be led astray by the low minded demagogue or the fanatic enthusiast. It is true that a people thus enlightened, will be more likely to look to their rulers for justice; but at the same time they will know how to appreciate good government when they have it, and this will be the surest pledge and guarantee for the integrity of those who govern; nay, it will have the effect to make good government the aim and ambition of the legislator, from his being sure that the public voice will always recognize and applaud, every measure which has its rise in honourable views or virtuous principle.

But the spiritual influences of religious instruction, are far greater and more promising than even these, as the present depravity of morals in England is far more alarming than the state of public opinion, and calls for measures at once prompt and efficacious. Man born and brought up in a state of savage ignorance, is indeed a melancholy object for the contemplation of the philanthropist. Darkness is his light; he says to himself, "evil be thou my good;" he looks with indifference upon the glorious works of nature around him; and virtue, struggling for her prerogatives within his breast, finds herself overpowered on every side;—his soul is "cabined, cribbed, confined," and pressed down by the weight of its worse than Egyptian darkness: but distressing as may be the state of the untutored savage, to the contemplative mind, far *more horrible, for* it brings even a terror to the *beholder, is the* state of those, who, born amid a

civilized community, and with splendour and wealth and luxury flashing around them, are left a prey to the conflicting tumults of an uncultivated mind, and the uncontrouled influence of passion and exasperated feeling. The man thus situated, looks around, and finds himself enslaved by customs, the nature of which he cannot comprehend: stung by poverty and hunger, he looks upon title and wealth as the tyrants of his being,—he feels that the world is not his friend nor the world's law; and looking on those who are born to be his rulers, he imagines that disdain sits in every eye that looks upon him, scorn in every lip, and that each arm is raised to shackle him, and that each hand contains a fresh rivet for the chain that environs him. When the spring puts forth her blossom it raises in him no sensation of hope; the summer's sunshine cheers him not, and he feels that the rich profusion of autumn that should fall for all, falls not for him: the whisperings of that better spirit he despises; and, like the deaf adder, he refuses to hear the voice of the charmer, charm he never so wisely. Under so dreadful an excitement, crime succeeds to crime, outrage upon outrage trample down God's image in his breast; guilt becomes at last a glory to his brow, and the spirit of the first born, Cain, reigns in his bosom.

But how widely different is he who has his mind enlightened by the blessed doctrines of *christianity*; who, like the pious Timothy, has *from a child* known the holy scriptures, and has *had their* glorious precepts firmly and unerali-

cably impressed upon his mind. Such a man will feel it his duty to make every exertion to support himself by honest industry; but should he be unsuccessful in his endeavours, the precariousness of subsistence will afford him no alarm, because he will know that not a sparrow falleth to the ground without the especial mandate of his heavenly Father; and thus he will be further instructed to bear indigence and poverty, not only calmly but cheerfully. The deceitful vanities of the mind he will learn to despise, and he will not envy those who make them their delight, from his firm conviction of the perishable quality of sublunary things: he will consider sorrow as the natural allotment of man, and misfortunes, whenever they assail him, but as trials for the exercise of his faith and patience: virtue and conscious integrity will support him in the severest troubles: hope, springing eternally in his breast, will lead him in the gloomiest moments to rest and expatiate on a life to come: faith will exalt him to the enjoyment in idea of a happier world, and give him a foretaste of the glorious things which God hath prepared for those that love him; while humility will soften every extatic wish, and throw her benign influence over his fluttering spirit. If pressed down by an accumulation of distress, he will recollect, that the son of man had not where to lay his head; and if he should recognize the contempt and hatred of the world, he will reflect, that it hated his Redeemer before it hated him; and *instead of repining* at his misery and lifting his *hand against* mankind, he will pray to the four

tain of all mercies for that balm of consolation, the Holy Spirit, in the full assurance that it will arm and fortify him against the machinations of the evil one,—guide him onwards and onwards unto all truth, till his spirit shall find its eternal repose in the bosom of its Father and its God.

Considering education in this light, as all must consider it who turn their serious attention to the subject, is it not really marvellous to find so few willing to patronize the object, or to join in so promising a cause? It is true, that men's minds are divided on certain speculative points connected with the question. Some have their doubts as to the efficacy of education to raise the *moral* character of the people, and have imbibed the idea, that knowledge to the poor is as a weapon in the hands of a madman: some have their doubts with respect to the methods or systems employed in communicating instruction; others would wish to impose peculiar religious tenets on the pupils; but the larger number by far are those who, engrossed by their worldly concerns, view with a heartless apathy or heedless indifference, the vices, crimes, and misery, characteristic of the present age.

To the first class of these, whose contracted and prejudiced minds lead them to imagine, that to illuminate the head is to extinguish the heart, and who would assert that the effect of education is to produce a nation of disloyal, dishonest, and insubordinate thinkers, and induce less morality than what can now be recognized, it may be said in answer, as one fact is worth a thousand arguments, let them look at the free states

of Germany, in comparison with those under the Austrian government; let them mark the difference between the protestant and catholic cantons in Switzerland; or, if they would have an answer from a country nearer their own, let them behold Scotland, the poor of which country have already decided the important question, although even there education has not been carried to its proper extent. In Scotland the poor can read, and yet they are loyal; they can write, and yet they are honest; they can calculate, and yet they are virtuous. The dismal glen, the barren heath, and the mountain tops, are radiant with the rising beam of knowledge: the peasant, the labourer, and the mechanic, all drink of the stream of human instruction, which, instead of intoxicating them with high ideas, and lifting them above honest labour, has taught them to understand and appreciate the astonishing effect of exertion, activity, frugality, prudence, and perseverence; it has implanted in their minds firmly and uneradicably this often quoted but no less important truth, that "knowledge is power," and acting upon it, the busy Scotchman is seen, either arduously and manfully struggling for a comfortable independency in his own country, or working his way into the south by dint of his acquirements alone, to the supplanting of the ignorant and boorish Englishman, threatening to hold over England herself a mental sway and intellectual dominion.

To that class of persons who have not made up their minds as to the superiority of one or the other of the systems employed, for the diffusion

of instruction, or who are prejudiced in favour of any particular method, I would observe, that as the great end of all our exertions in this cause ought to be the promotion of sound, clear, and practical religion, the system or systems in which religious instruction forms the most prominent feature, must unquestionably be the best; for wherever the spirit of a rational and practical religion exists, it will throw such an order, propriety, and solemnity, over the daily business of a school, that subordination, and consequently a rapid proficiency in the several elements of knowledge, will be the inevitable results. The system called "The British," invented at the close of the last century by Joseph Lancaster, may be said to unite all the excellencies of the various methods of teaching previously employed, with the additional recommendation of cheapness, which has opened a door for the education of all. In a school on this system, is to be found, every facility for instruction which human reason can suggest, and every guarantee for a pure faith and right spirit of religion, which the most fastidious may require. It holds out to the pupil such an acquaintance with the elementary parts of knowledge, as is sufficient to enable him to execute with propriety the usual business of ordinary life, and that by methods which carry with them the most comprehensive moral effect, adding to the precepts of subordination which are enforced, striking illustration and example. In the common methods of managing a *child* at school, a blind mysterious reverence *alone binds* his obedience to the superior; he

submits, indeed, but it is from the fear of the rod, and not from a conviction that it is to his interest in any other respect to do so; consequently, when he emerges from the authority of his teacher, he is too apt to consider himself upon a par with every body he meets, and has not the least idea of the respect due to rank, talent, or superior acquirement; thus reproof is scorned by him, and good advice thrown away upon him: but to a boy educated under the monitorial system, the habits which he acquires have quite a contrary effect; he feels himself from the first thrown upon himself and his own resources, and surrounded by a little world of human beings, of the same juvenile standing with himself, he soon finds the necessity of submitting to those whom talent and propriety of conduct have made his superiors; they are taught to act towards him with justice, and he bends to their authority, feeling it to be both his duty and interest to do so. These impressions he carries with him into the affairs of the greater world, and the general concerns of life; and, from parity of reasoning, he believes that men in higher stations than himself have a corresponding claim upon his deference, and he feels the necessity and virtue of paying it; he has seen vice disgraced and virtue extolled at school; he has felt that merit alone entitles him to respect and esteem; and carries with him the conviction that virtue and propriety of conduct will always meet their reward. To produce such a wholesome effect upon the mass of the population of a country, and by means so simple and available, is almost beyond what the great-

est lover of subordination and order could have wished; this with its other advantages, renders the mutual system of instruction the most excellent that has hitherto appeared.

With regard to the peculiar religious opinion to be engrafted in the minds of the people, I trust that every candid mind will allow, that it is proper on all occasions to pay a due reverence, not only to religion, but also to those established ecclesiastical ordinances and ceremonies which the custom of a country enjoins, and which the sterling virtue of past ages and the wisdom of our forefathers seem to have consecrated: but in paying a reverence to the rites of a national church, and a due deference to the opinion of its living ornaments, we must be careful that we do not exceed the bounds of propriety, and offend Religion herself. There is a divine principle in the human mind, springing from a right perception of justice, which all good men recognize, and which claims a far greater reverence than human ordinances;—namely, the right of the heart to worship the Creator according to the dictates of the spiritual inmate by which it is guided. The enlightened mind may distinguish, and right reason may point out to us, the unostentatious, simple, and beautifully impressive ritual of our church, but true christian charity and brotherly tenderness will at the same time teach us to make allowances, for those differences, which we can only consider the natural infirmities and constant aberration of the human *mind*, and thus we shall not endeavour to force *the consciences* of the meanest of the brethren,

by the introduction of any peculiar religious tenets, or by making it imperative on those who receive the benefit of instruction, to attend any particular place of public worship.

Now such a principle is the distinguishing characteristic of the British system. It opens the road to instruction, but imposes no religious creed; it places the holy scriptures in the hands of its pupils, but dare not say, 'this passage thou shalt believe, and this thou shalt reject.' It plants the tree of life in all its fulness of blossom beside the tree of knowledge, but it cannot suffer earthly fire to mingle with the heaven-lit flame upon its altar.

It is these principles that render the "British System" in *Education* what the British Constitution is in *Government*, so pure and perfect in its kind as to be absolutely 'sui generis.'—Having its foundation on the holy scriptures, liberty of conscience, and the incontestible religious rights and common privileges of man; the glorious superstructure stands securely on the rock of ages, and braving the wind and the wave of conflicting opinion, it may be compared to that perfect piece of masonry on the Eddystone rock, which not only withstands the tumults that surround it, but illuminates the wave that would hasten its destruction, shedding a glory and a warmth over the dark minded and the cold. Thus with the will of the Deity hung around its walls, order, heaven's first law, enshrined within its precincts, and with a concentration of moral *truths more precious* than wisdom's sublimest *recepts, and* most refined speculations, trea-

so dull as not to comprehend the mighty influence a country attains in the scale of nations by intellectual superiority; and blind indeed must such be to the rays of moral truth, who remain unconvinced of the great importance of National Virtue, and who do not view it as the cement which will alone preserve the civil compacts of society; for where is the legislator who has not felt the inefficiency of his enactments to prevent evil, and who has not been convinced that the deep seated perversity of the human heart is not to be rooted out by penal statutes or public executions.

Nor ought education less to interest the philanthropist, the philosopher, and the divine. The former will not be able to find, among all the calls upon his benevolence, a cause so important as that which professes to strike at the root of moral evil, to nip sin in the bud, and to prevent by timely interference the enormity of vice, from striking her brachia of crime, through the intricate ramifications of society. It may, indeed, be well to raise the fallen, to administer to disease, and to physic the perishable body, but it is far more an object of noble ambition to exhibit in early years that precious medicine to the soul, which will in after times have the power to

" Pluck from the memory a rooted sorrow,
" Rase out the written troubles of the brain,
" And with a sweet oblivious antidote,
" *Cleanse* the foul bosom of that perilous stuff
" *That weighs* upon the heart."

with feelings of a sublime and godly de-
that we contemplate a Howard descend-
the lazar-house, braving the destroying
of contagion with a smile; but it is no
source of sublime and exalted emotion, to
a Lancaster struggling against the bigot-
vices of an age, energetically employed
oving the obstacles to the emancipation of
d, and like the angel at the resurrection of
deemer, rolling away the stone from the
of the sepulchre, that the Lord of life and
ay arise.

no less force must the importance of
on strike the true philosopher; for reason
own him in his researches through the
ious and almost infinite gradations of
rising from the mineral to the vegetable,
ie vegetable to the animal, and from the
to the spiritual world, that *man* is the
created to fill that wide hiatus between
d deity. He finds him the last link of
ain, which from an atom to himself, is all
h, connection, harmony, proportion, and
a chasm; and feeling this, must he not
r at the idea, that man, the all in all of
ce, "so noble in reason, so infinite in fa-
in form and moving so express and ad-
, in action so like an angel, in apprehen-
like a God,"--should be doomed to mental
m and spiritual darkness, and be preclu-
m all enjoyment except that which pro-
from mere animal gratification: but on
er hand, when he views the efficacy of
l of education, and its applicability to

the mass of mankind, how ardently must he rejoice, in knowing that it is possible for the meanest of his species, to attain by a simple process, unburthened with refined speculations and laborious deduction, knowledge, more exalted than ever human reason could acquire, from its containing the essence of the divine will and attributes in all their beauty and perfection, which, shining about the spirit of man, clothes him with immortality as with a garment, and lifts him at once to joy unspeakable and full of glory, and to the clear and perfect view of those precious things, of which philosophy but gives, the incoherent, dim, and shadowy outline.

But far more interesting to the Divine, than even to the statesman, legislator, or philosopher, must the cause of religious education appear, inasmuch, as his views are more elevated, and his designs extend much further than theirs;—earth may bind the aspirations of the statesman or philosopher, but those of the divine stretch even unto eternity. Commissioned to turn the hearts of the disobedient to the wisdom of the just, how gratifying must it be for him to behold education going forth like the Baptist of old, preparing the way of the Lord, and making in the desert a pathway for our God; and what sensations of delight must he experience, to see the early inculcation of those divine truths and precepts, which in after times he will have to propound, expatiate on, illustrate, and enforce: *viewing, then,* this kind of education, as the *most perfect,* available, and valuable auxiliary *religion can* possibly receive, the christian Di-

vine may hail it as a chosen mean and instrument for the speedy establishment of the Redeemer's kingdom upon earth, and the drawing together of all nations in the unity of spirit, the bond of peace and righteousness of life: elevated by such sublime contemplations above the clouds and mists of prejudice, as the Patriarch from the top of Pisgah looked in tears of joy upon the promised land, so will he cast an undimmed eye upon the distant prospects of futurity; and with his daily supplications to the Almighty, that peace and happiness, truth and justice, religion and piety, may be established among us throughout all generations, he will not fail to unite the christian's labour of love in a cause, which appears so essential to the present and eternal interests of mankind, and so consonant with the manifest designs and the will of the most high.

Oh what a glorious victory
Is that which spirit's heaven-born spark
Gains o'er the snake-like thoughts that lie
In venom nestling at the heart!
What brightness hath instruction's ray,
That turns the mental night to day!
And opens to the anxious gaze
Of the young soul each new delight;
Creation's laws, the stedfast blaze,
Of all that's beautiful and bright;
And lifts it from them to the throne
Of the Eternal Glorious One!
Encompassed with the joy, to know
That, 'though from Eden's glory driven,
His spirit will attend to show,
The trembling soul its road to heaven!
Oh, say, are not these tasks divine!
And these Instruction—these are Thine!

ASIA.

He maketh His Sun to rise on the evil and on the good,
And sendeth rain on the just and on the unjust.
Matthew c. v.

Oh climes of the sun, where the vulture's fierce eye,
Melts to love in the soul soothing tints of the sky;
And Eden's proud bird, soaring heaven-ward alone,
Looks to glass his bright plume in the disc of the sun;
And where to make each hour pass cheerful and bright,
Golden pheasants by day, and fire flies by night,
All glisten with joy as they wing through the air;
And the soft breath of even seems teeming with prayer,
As the humming bird's hymn and nightingale's lay,
Chaunts the fever and wrath of the bosom away.
Oh BEAUTY that walketh in fulness of bloom,
'Mid the incense of vows, and through groves of perfume;
The clear cloudless azure of heaven spreading o'er thee,
And the radiance of sun-light dancing before thee:
'Tis here in these climes, not a tree nor a flower,
But exults in thy magic and owns to thy power;
No bird fans the air but hath something of thine,
Which he gives out in song or in love at thy shrine;
Nor insect nor reptile of vilest degree,
Liveth here but holds something in rapture from thee.
Oh GRANDEUR enthroned on the bold mountain's brow,
With thy mantle of gold, and thy turban of snow;
On which the sweet moon shews her crescent less pale,
And the condor shouts triumph in face of the gale:
Even here from high peaks full of haughty disdain,
That hurl down the Ganges in foam on the plain;
May man's spirit triumph o'er nature and time,
As it quenches its thirst in emotions sublime.

Oh GLORY uprising from earth and from sea,
In sun-light, in star-light, in rapture, in glee,
Flowers that glisten in odour and sparkle in dew,
Birds that change with the daybeam their plumage anew,
Piles of crystal beneath the emerald wave,
Gems and pearls that profusely the ocean beach lave.
And brilliants that tremble in brightness, and gleam
In smiles and in joy, 'neath the glittering stream;
Clear gum drops that offer yourselves to the ray,
Of the love making sun in the zenith of day;
From boughs where the luscious pomegranate and pine,
With the fig tree and date as enamoured entwine;
Rills of naptha lit up by the lightning, that hold
Your course in bright flame over topaz and gold;
And thou heaving ocean whose bosom is bright,
As some sultan's cuirass in the heat of the fight;
Wilt add to the glory and beauty thus thrown,
O'er the plains of the east and the climes of the sun.

But for whom do this glory and loveliness shine,
For the souls of the just, or for spirits divine?
Oh no! for amid all those vallies so mild,
And those hills sweet and calm as some slumber-bound child;
The dragon-like mind and the tiger-like breast,
Cold in love, fierce in hate, make tumult their rest;
The rapture of praise, and the fervour of prayer,
Ascend not to heaven in the morning's kind air;
No spirit bows down unto God in the ray,
Of the breast-thawing sun at the close of the day:
But a thousand dark eyes are lit up by the fire,
Of the volcano heart overflowing with ire;
And curses and scorn are most fearlessly thrown,
From its depths to the face of the glorious ONE.

Oh THOU that in mercy and goodness doth shed,
Thy gifts without store on the unworthy head;
And withholdest not e'en from the base and the vile,
The dew and the rain and the sun's golden smile:
Teach us who would walk in thy wisdom and light,
And feel thy pure essence each moment more bright;

To implore some faint spark of thy grace from above,
When we roam through the scenes of thy bounty and love;
And as thou send'st the dew drop and sunshine on those,
Who scoff at thy will and are armed as thy foes;
So let us cast on him, who would hate us, an eye
Mild and soft in its gaze as an orient sky.

CHAPTER I.

ASIA is bounded on the north by the Northern Ocean; on the south by the Indian Ocean; on the east by the Pacific; and on the west by Europe, the Black Sea, Mediterranean and Red Seas. It is divided as follows:—

In the north, Russian Tartary and Independent Turkey; in the centre, Chinese Tartary and Tibet; on the east, China and Japan; on the west, Persia, Arabia, and Turkey; on the south, lie Hindoostan, British India, the Tonkin Empire, and the Birman Empire.

The principal Islands are, those of Japan in the north east, the Phillippine in the south east; the Molluccas or Spice Islands, and some of the Greek Islands in the west; and the Islands of Sumatra, Java, and Borneo in the south.

The chief Peninsulas are, those of Hindoostan, Mallacca, Corea, and Kamtschatka.

The chief Capes are, Cape Romania, Cape *Comorin*, Cape Lopatka, with North Cape and *East Cape.*

The principal Seas, Gulfs, Straits, &c. are,

the Red Sea, the Arabian Sea, the Caspian Sea, Chinese Seas, Sea of Celebes, and Sea of Kamtschatka; with the Gulf of Tonkin, of Persia, of Corea, the Bay of Bengal, of Siam, of Nankin. The Straits of Babelmandel join the Red Sea with the Indian Ocean, and the Isthmus of Suez joins Asia with Africa.

Asia is the richest and most prolific quarter of the world, and has been from the earliest period the scene of the most important transactions, including the creation of man, and all those sublime events recorded in the Sacred Writings. Asia was also the seat of the three greatest empires that have ever existed in the world; the Babylonian, the Assyrian and Persian; and it was in Asia, that those destroyers of the human race called conquerors, exhibited their atrocities in the most awful degree. Alexander, Jenghis Khan, and Tamerlane destroyed their millions, and desolated the fairest portion of God's earth; while Mahomet rose in the scale of evil, and incorporated with the rueful trade of arms, absurd, dangerous, and prepos-terous observances; being willing to obtain the same dominion over the *minds* as over the *bodies* of mankind.

The inhabitants of Asia, are of course varied in a country reaching from the equator to the mid zone, and stretching from twenty-five to one hundred and eighty degrees of east longi-tude; and will be found of every variety of complexion, from the fairness of the Circassian, to the *blackness* of the Malayan. Customs, manners, *and* habits vary in a similar degree.

The Tartars who are the Scythians of antiquity, are fierce, inhospitable people, leading in general a wandering life. The Arabs who are the descendants of Ishmael, of whose posterity it was foretold, that they should have, "their hands against every man, and every man's against theirs," live a remarkable fulfilment of sacred prediction; robbers by profession, they traverse the country in troops on horseback, and plunder all that they meet; while on the sea they live by piracy, and make prize of every vessel they master. Asiatic Turkey, or Asia Minor, where "Solomon in all his glory" astonished mankind by his wisdom and magnificence, and where once flourished the seven Churches, mentioned in the Revelations; is now a theatre of ruins, and the inhabitants barbarians, living in continual struggles and bloodshed with each other. Persia, once the seat of the Babylonian Empire, of the conquests of Alexander, and of the cruelties and excesses of Thamas Kouli Khan; who raised it into a powerful kingdom, is even now remarkable for splendour and magnificence; but its inhabitants are generally voluptuaries, and live in the commission of the most horrible offences. China, the inhabitants of which are more social than in any part of Asia, appears to have subsisted through many centuries, with but few political changes, or intestine convulsions, enjoying the blessing of peace, and remaining unsubdued. In Japan, the people *are ingenious,* but their manners are quite *opposite to those of* Europeans. India, is divided *into, India within* the Ganges, containing Hin-

doostan and British India; and India without the Ganges, containing the Birman and Tonkin Empires. In the former, Hindoos, Mahometans, and Europeans indiscriminately mix. The Hindoos are of a black complexion, and are divided into different tribes or castes; the four principal of which are, the brahmins or priests, the soldiers, the labourers, and the mechanics, including tradesmen, merchants, &c. with another which is the outcast of all, and performs the most disagreeable offices of life. All the different tribes are forbidden to intermarry, dwell, eat, or drink with each other. The Mahometans are very corrupt, and it is to be feared that Europeans, although professing the religion of Jesus Christ, are in many instances, inferior in moral conduct to the native idolaters of the country, or the followers of Mahomet. In the Birman Empire, a fierce and sanguinary race of people exist, who, in the Malayan provinces, differ little from brutes in their manner of living; while in the empire of Tonkin, (lately liberated from the yoke of China) the people are honest, modest, and hospitable, even in the least civilized parts.

Intellect and men's minds differ in Asia, more than even complexion or character; and we behold in general the most execrable superstition, the most fanatic bigotry, and absurd idolatry, out of which proceed the most vicious habits and unnatural customs. The Mahometans, believing that their religion shall be established by the sword, live in a state of continu

warfare. The Hindoos,[1] thinking that Bramah, their deity, enjoined their divisions into different castes; instead of living in amity with each other, stand coldly aloof, and would rather suffer a drowning man to perish, than fly to his assistance, for fear of pollution: these people have a horrid custom of suffering widows to burn themselves with the bodies of their husbands. The Mogul Tartars are deists, and hold it to be absurd to worship the Deity.[2] The Schamanes believe in one Supreme Being, but that mankind are too insignificant to offend or please him by their actions. The Koriaes, a people north of Kamtschatka, although believing in the

[1] The book that contains the principles of the Hindoo religion, is called the Vedam, and is universally received. The Shaslah is a commentary on the Vedam, and teaches the doctrine of transmigration, resembling the metemsychosis of Pythagoras. The Hindoo believes that the souls of all animals are rebel angels, undergoing expiatory stages of existance, until they enter into the human form, when a life of probation begins; that in this state man becomes a free agent; that his good or bad conduct hastens or retards his pardon; that the good, at their death, are re-united to the Divine Being, and that the wicked begin anew their period of expiation.

[2] The Chinese Tartars worship the Grand Lama, whom they pretend is always young and immortal. To keep up this opinion, the priests purchase some young healthy peasant, whom, after having prepared for their purposes, they transfer to a pagoda, on mount Putuli, where he sits in a cross-legged posture, without speaking, merely lifting his head in approbation *at a favoured* worshipper; when this person begins to *grow old, he is* privately dispatched, and another as *like him in features*, as can be obtained, is purchased, *to carry on the* deception.

istence of a good God, yet offer up sacrifice
d prayer to the devil; and drunkenness is
nsidered with them a religious practice, and
ms a prominent feature in their solemnities.
Japan, the religion is paganism, but there are
o sects, one of which is subject to the most
inful severities; and many may be noticed
bjecting themselves to the most excruciating
rture; some are seen swinging their bodies to
d fro, suspended by hooks, driven through
eir flesh, some constrain themselves to the
ost unnatural posture for years together; others
t and maim themselves, lie on beds of flint, or
fer their children and themselves as sacrifices
their gods. The other sect lives in the en-
yment of the most voluptuous excesses. In
ina there is no established religion, nor is any
id, preferred, or encouraged by the state; the
ople are at once deists and idolaters, and have
merous temples and household gods. There
e several religious sects in China. The em-
ror being of the Tartar race, follows the reli-
on of the Delai Lama, while the people follow
me Le Laokun, some Confucius,[3] the Chi-

[3] Confucius, who flourished about 500 years B. C. once the Solon and Socrates of China, promulgated most excellent system of natural religion, and ught, that God was a most pure and perfect prin- ple, and the fountain and essence of all things; that enjoined on his disciples the strictest morality, a gregard of riches and worldly pleasure, and the ex- cise of every virtue; and by the innocent sanctity his manners, he recommended his precepts by that *pressive language*, which speaks more forcibly than rds—*conduct*.

nese philosopher, and others Fo Hi, the founder of the Chinese Empire; these they exalt into deities, to which, with others of more subordinate characters, such as the inventors of the arts and sciences, they pay adoration.

This is indeed a frightful picture of the present state of this portion of the globe; and the only relief to so gloomy a sketch, is the few scattered stations and colonies in various places, where missionaries have began to preach salvation in the name of Jesus Christ. In many instances, doubtless much good has thus been done, and many souls have been delivered from the power of satan; but it is nevertheless the duty of the true believer, not to look for much through human means, but for that universal and powerful manifestation and pouring out of the spirit upon all flesh, and to wait with humble faith for the working of the Almighty, who will, in his own good time, bring all nations and kindred and people unto himself, to live with Him and the Lamb for ever and ever.

Before we conclude this chapter on Asia, we would make a few observations on the blessings of Peace. There is but one country in the world where this virtue has been duly cherished and cultivated, and that country is confessedly, in spite of its absurd systems of religion, the most wealthy, prolific, and happy country in the *world. China* contains three hundred and thirty-*three millions* of souls, who live in the greatest *harmony, safety*, repose, and civil concord. In

every part of this vast country the tillage is so excellent, that the land appears divided into a succession of gardens; arts and trades are in such a high state of improvement, that the dwellings of the meanest of the population, exhibit conveniences of which Europeans have scarcely an idea: manufactures by machinery have reached to such excellence, that no foreigner is encouraged to introduce his discoveries, and scarcely an article of consumption is used that cannot be supplied from their own recourses. Canals, some of them more than three months sail, are to be found in every province, to facilitate the conveyance of merchandize to every part of the empire. Fishing and coasting vessels cover the shore for many miles; monuments of art, refinement, and luxury, are to be found in almost every village; while the meanest of their cities rival the proudest of European ones, and London, Petersburg, and Paris would be held as cities of the third order. To conclude, China, through the cultivation of the spirit of meekness, gentleness, and peace, is the happiest country that any age has produced, and is as much elevated above european nations, as the present inhabitants of England and France are over the inhabitants of Sweden and Norway, and stands an illustration of the Redeemer's words.

Blessed are the meek, for they shall inherit the earth.

Matthew c. v.

AFRICA.

Think not school-polished man,
That liv'st amid the silken ceremony
Of civilized connexion, and dost quaff
Life like strong wine, and drain'st the gilded cup
Of pleasure to the very dregs, that these
Wild deserts and inhospitable wastes,
Where the fierce sunbeam seems to scorch the tear
Of pity from the flashing eye,—alone
Are big with horror,—for within the glare
Of dazzling cities, and 'mid crowds that throng
The temples, halls, and gorgeous palaces
Which boasted reason builds and pride sustains,
Dark passion walks abroad in the bright sun;
And 'neath the glow of fashion's midnight splendour,
Strifes, wrongs, and crimes, do live tumultuously
In men with fiend-like hearts, demoniac spirits,
And fierce hyena natures.——Raise the veil
My trembling hand; and, oh! let fashion, pride,
And rank behold!—look at you, piteous thing!
Once beautiful as Hebe, on whose form
The bright eye wept in extacy of joy,
And in whose gentle bosom early love
Slept like the fires on Heckla's burning hill,
Wrapt in the chastity of snows:—but now
How dim her eye, how pale her cheek, how dried
With potent sorrow and dark grief the breast—
First worshipped, and then wronged, and spurned and
loathed,
And left to perish in increase of crime;
Multiplying through the dark infinitude
Of guilt and horror.——Tell me then, ye vain,
Is there a beast in Afric's burning soil,
Though full gorged with the blood of innocents,
Like the fell monster that could make such ruin?

Behold yon smiling wretch, who stands above
The prostrate body of his early friend;

First he defiled the idol of his heart,
Then pierced that heart with steel he had before
Sear'd with accursed deeds:—And what is, then,
The savage who drinks reeking blood, and eats
The flesh of his fierce foe in joyful rage,
To one of fashion's darling children, seen
So black in heart, so gorgon-like in mind?

No more!—the soul shrinks back with horror.—Oh!
Ye wretched, thoughtless, heartless multitudes,
That over unsophisticated nature
Pretend to shudder.—Oh be still, be still;
First quell the strife, the tumult, rack, and rage,
Of thy innumerable and mighty cities;
Be the loud song of phrensied triumph hushed,
And be the flesh gorged sword of ghastly war
In pity sheathed. Black stalker in the gloom
Of ruffian midnight, hold thy desperate hand:
Look up, look up, Oh vengeance, deign to raise
Thy burning eye-ball from the thirsty steel,
And wipe that passionate foam and frothy rage
From thy parched lips. Down, down, rebellious flow
Of the hot blood,—shrink up thou bitter gall,—
Lie still envenomed tongue: hold hand, hold heart,
From deeds most devilish; and every wild
And mad and drunken energy of flesh;
The rush and war of mortal elements
Against the Godhead—pause.

CHAPTER V.

Boundaries.—AFRICA is bounded on the north by the Mediterranean; on the south by the Southern Ocean; on the east by the Red Sea and Indian Ocean, and on the west by the Atlantic.

Divisions.—Africa may be divided into Barbary, extending along the Mediterranean, fr

the Straits of Gibraltar to the Lybian Desert; including the Mahometan States, called Tripoli, Tunis, Barca, Algiers, and the Empire of Morocco; Egypt lying on each side of the Nile; Upper Ethiopia, which includes Nubia and Abyssinia; Lower Ethiopia, extending through the interior of Africa; Guinea, divided into the grain, the ivory, and gold coasts, and the kingdom of the Ashantees.

The chief Islands are, in the west, the Madeiras, Canary Isles, Cape Verd Isles and Goree; on the east coast, Madagascar, Bourbon, Isle of France or Mauritius, Comera Isles, the Azores, with Almirante Isles, Babelmandel and Socotra.

Capes.—On the north, Capes Serrat, Rossem, and Bon; on the east, Aguillas, Corientes, Guardafui; in the west, Badagor, Blanco, Verd, St. Mary, and Roxo; southerly, Capes Negro and Good Hope; while on the coast of Guinea will be found, Capes Palmas, Three Points, and Formoso.

Gulfs, Bays, Straits, &c.—Are those of Syrtis and Cubes, on the north of Guinea near the equator; Saldanha and Table Bay at the southern extremity. The Straits are those of Gibraltar, Babelmandel, with the Channel of Mozambique.

AFRICA is the weakest, the most uncivilized, and least known portion of the globe, and appears rather to be a part of the earth, reserved for wild beasts than for mankind; for it is here *that the most* ferocious of animals multiply in an *extraordinary* degree, and the most noxious and *dangerous* reptiles are to be found in dreadful

abundance. Man himself appears to partake of the brutal nature, and either lives like the beast of prey, by rapine and plunder, or sinks down in sluggish apathy and filth, with scarcely a thought for the morrow. In that part of the coast called Barbary, the inhabitants are generally composed of Moors and Arabs, who are ignorant, savage, and cruel beyond description. The Algerines are a nation of pirates, and in Tripoli and Tunis, the people are inconceivably indolent and filthy. About the Desert of Barca, which divides Tripoli from Egypt, and through the whole of Morocco, hordes of Arabs may be met, who live without any law save that of their captain, and make robbery their trade, subsisting upon the plunder they obtain. Travelling east, towards Egypt, we find extreme misery to prevail, above the ruins of former magnificence and glory, and the remains of temples, palaces, columns, statues, and paintings, that were once the pride of kings and the subjects of contention between the most powerful monarchs, and which obtained the wonder and admiration of the world. In Egypt, may be found, people of every nation, and of every religion, who subsist in mutual terror, or in dread of the incursions of the Arabs. The descendants of the original Egyptians, called Copts, who are the peasantry of the country, are an ill-looking, slovenly people, immersed in ignorance, making a miserable subsistence on a few onions, cheese, a little milk, a few dates, and Indian corn. Taking a more southerly course, and following the Nile, Abyssinia meets our attention; lying a little south of

the source of that river; and it is here, that a more decided state of brutish barbarism begins. The lower order of people in Abyssinia, like the Copts appear to be a distinct race from the rest, and are doubtless descended from the original inhabitants. The emperor and his subjects live in tents, but the people in huts, made of the boughs of trees, and subsist almost entirely on the natural produce of the country; but are continually engaged in civil wars. Descending towards the Cape of Good Hope, on the eastern side of Africa, we pass Mozambique and Zanguebar, which include several petty kingdoms, where the Portuguese have settlements, and the inhabitants are less barbarous. Monomotapa, lying a little to the south, is extremely fertile and healthy. Drawing nearer to the Cape, we reach Caffraria, where the natives, nearly black and very tall, live continually in warfare, and are in a complete state of savage barbarism. The Boshmen, who live adjacent, are however more degraded, and may be considered the very lowest of the human race; they are seldom five feet high, ill made, and very ugly, their hair is observed to grow not all over the head, but in small tufts in various places; they appear to live entirely like beasts of the forest. Roused from indolence only by hunger, they prowl about in search of food, plunder and massacre neighbouring tribes, using poisoned arrows; and it is said that they eat human flesh. The Colony at the Cape of Good Hope, is now in a state of great improvement; and ascending from thence northerly, we may enumerate the Hottentots, who are na-

turally indolent and filthy; but by the attention and kindness of the European settlers, and the governor at the Cape (who formed a regiment of Hottentot soldiers,) are now greatly improved in their habits; but far more good has been done by the missionaries to these people, who have not only instructed them in christianity, but taught them the arts, and made them acquainted with the comforts of civilized life. Ascending towards the gold coast, we reach the Fantees, and the interior kingdom of Ashantee, whose armies within the last fifteen years, have repeatedly overrun and reduced to a tributary and dependant state, all the nations on the coast. The capital of Ashantee is Coomassie, one hundred and fifty miles from Cape Coast Castle. The Ashantees are remarkably fierce and barbarous, torturing their prisoners with the most ingenious cruelty, and sacrificing hundreds at every public festival. On the death of the king's mother, a short time since, not less than three hundred human beings were butchered. It might be supposed that a people so sanguinary and cruel, were in the most wretched and abject state; but instead of this, the Ashantees have reached considerable proficiency in the arts, and are remarkable for the splendour of their warlike accoutrements, and the sumptuousness of their public festivals. Not less than five thousand warriors, all gorgeously attired, met the English embassy on a late occasion, with music, horns, drums, the sounds of gongs and firing of muskets. The dress of the warriors, was, a helmet with gilded ram's horns, fastened under thei

chins with bands of shells, surmounted by plumes of eagles feathers; the vest was red cloth, adorned with gold and silver; leopards tails hung down their backs, and from different parts of their bodies were suspended, small brass bells: they wore loose cotton trowsers, with red leather boots; a small quiver of poisoned arrows hung from their wrists, and they carried a small spear in their left hands, covered with red cloth and silk tassels.

The interior parts of Africa are but little known, a very large portion of its northern parts is one vast desert, in the centre subsist various wild tribes of people. In Tumbuctoo, one of the inland towns, on the south of the great desert, the people grease their bodies, and will bask in the sun at mid-day, and sleep without shelter at night, in the most disgusting and filthy manner. Nearer the sea, in a western direction, the people are less savage and better cloathed. On the north of the desert, behind Morocco, are found Biledulgerid and Fezzan; in the former, which is the ancient Numidia, the people upon the whole lead a more quiet life; in Fezzan, the people are a race partly moorish and partly negro, having the ferocity of the one joined to the indolence of the other. Mourzuk, the capital, has the appellation of a christian town, and exhibits a contrast of vast ruins, of ancient buildings and humble cottages.

AMERICA.

A hundred nations forged a chain,
For nature's untamed sons in shame;
And many a king across the main,
Sent forth a rivet in his name,
And still with whips and brands they came:
But Penn alone, unarmed and mild,
As mercy's dear and kind behest;
Approach'd his brother rude and wild,
And clasp'd him to his breast.

Oh he was freedom's noblest son,
And bravest champion, for he ne'er
Drew sword to move the widow's moan,
Or the despairing orphan's tear,
Above its slaughtered parent's bier;
The champion that truth could hail,
And whom no pains or strifes could move,
Who wore for weapon and for mail
His bosom's light and love.

The king[1] that at Thermopylæ
Fell in the pompous Persian's blood;
The youth[2] of matchless bravery,
Who dar'd all arm'd the granic flood,
Nor he[3] that gloriously withstood
Ambition, stalking o'er the world,
Gorgeous and bloody in his line,
And with a bleeding bosom hurl'd
Him down at freedom's shrine.

1 *Leonidas.* 2 Alexander. 3 Marcus Brutus.

Nor he,[4] who on the judgment seat,
Trod on the pleading father stern,
Forbidding nature's pulse to beat
Or fond parental love to burn,
Except above his children's urn;
Who bade the lictor band depart,
To strike his kneeling offspring low
For justice sake, although his heart
Was withered by the blow.

Nor thou[5] decreed by mandate vile,
To die for that celestial light,
Didst drink the hemlock with a smile,
E're Bethlehem's star shone on the night
Of darkness, like a beacon bright;
Nor Thou who threw thy armour down,
Thy sword and crest of victory,
To clasp thy Saviour's cross and crown,
Wert not more great than he.

Thou land of rising glory, thou
Fair land of promise, I would fain,
Bless thee with his pure spirit now,
Across the wide and desert main;—
That wish is not entirely vain,
The bare red arm to heaven is rais'd,
The tomahawk is thrown away;
And fading nations stand amazed
And lost in virtue's ray.

Upon those shores, upon that land,
Thy name, oh! Penn will be a charm,
To wrest from the determined hand,
The vengeful knife and stay the arm,
And fill the troubled breast with calm:
And when those deeds that men miscall,
Most glorious shall withered be,
Upon the scroll of time,—yet all
The earth will know of thee.

4 *Lucius* Junius Brutus. 5 Socrates.

CHAPTER VI.

vast continent of America, extending
from pole to pole, is washed on the
ı side by the north and south Atlantic,
ı the western by the north and south Pa-
It is divided into North America and
America; which great divisions are joined
arrow neck of land in the centre, generally
the Isthmus of Darien.

rth America, includes, first Labrador,
on's Bay, Upper Canada, Lower Canada,
Brunswick, Nova Scotia; situate in the
rmost parts and under the dominion of the
ı crown. Secondly, the United States to
ımber of twenty:—these are, on the north
Massachusets, New Hampshire, Vermont
e Island, Connecticut:—in the centre New
Pensylvania,[1] New Jersey, Delaware,
and, Virginia. Behind in the interior, are
chy, Tenasse, Ohio, Indiana, Illinois, and
ana: in the south the Carolinas and Geor-
o these are attached, the Mississippi, Mis-

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he founder of Pensylvania was William Penn, a
r of the Society of Friends, (commonly called
s), who, in 1681, obtained the royal charter to
here. Penn, instead of entering the country
in hand, like the infamous Cortez, and Pizarro,
ought the land which he himself and followers
d of the Indians, and concluded with them a
of friendship and peace. A justly celebrated
has observed, that this treaty was perhaps the
made without the impious ceremony of an oath,
e only one that has not been violated.

souri; North west, Michigan, Alabania, and Arcansan territories. The Spanish possessions in the south are, East Florida, West Florida, California, New Mexico, and Mexico.[2]

The chief Islands are Newfoundland, Rhode Island, Long Island, and others. The principal Lakes are Lake Superior, Michigan, Huron, Erie, Ontario, Winnipeg, and Stone Lake.

The principal Bays, Straits, &c. are Hudson's, Baffin's, Delaware, Chesapeak, Campeachy, and Honduras Bays. The Gulf of St. Lawrence, of Florida, and Mexico:—on the west coast are the Gulf of California, Nootka Sound, Behring's Straits, and Bristol Bay.

It is little better than three hundred years, since Christopher Columbus discovered America, where nothing was to be seen but vast forests, prairies, and savahannas; but now we see many independant kingdoms, and cities that scarcely yield to the first of European cities, for the comforts, conveniences, and luxuries of civilized life. The United States at the present moment upwards of one thousand miles in extent north and south, and stretching more than

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[2] Mexico, the capital of the Spanish possessions in N. America, was taken by the execrable Cortez, in 1521, who found it a flourishing city: from this time till the year 1810, it was governed by a Spanish Viceroy, but a struggle for independence commencing that year, the Viceroy departed, and in February, 1821, it was declared free, with the rest of the country. The city of Mexico *is immensely* rich, enjoys a prodigious commerce *although situated* at some distance from the sea, and *the centre of* all the trade carried on between Spain *America and* Europe.

six hundred miles inland, rivals England herself in political power, and surpasses her in extent of territory. Although composed of all nations upon the face of the globe, and embracing almost every variety of religious faith, in the United States may be found the greatest politeness, toleration, and brotherly union. Their form of government,[3] although perhaps not equal with that of the mother country (England,) is nevertheless, creditable to good sense, prudence, and moderation; and when we consider that religion although unprovided for by the constitution, is in no way neglected, we must conceive favourable opinions of the virtues and good feeling of such a people.

The Americans are making rapid strides in every department of literature and science, the arts, manufactures, and commerce. The trade of Boston, New York, Philadelphia, and Charleston within these few years has improved surprisingly, several of the territories are rising into independent States, every two or three years, from the increase of population, and in a very short portion of time, America, called the new, will rival the old world.

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[3] The form of government is the Republican, governed by a President, who is elected by the people every four years.

SOUTH AMERICA.

LIBERTY!

So the feigned idiot[1] said, when from a breast
Pure as the snowdrop's dewy tear, he drew
The deadly steel, and on his bended knee
Swore dreadful enmity to those who stood
Upon the neck of Rome.——'Twas *Liberty!*
While his torn heart wept blood, and nature shook
The spirit in its mighty citadel,
Kept the fond *Father* firm.——For *Liberty!*
Cried the Centurion[2] wildly, when he plunged
The knife into the bosom of his child,
And hurl'd the base Decemvir from his throne!
For *Liberty!* For *Liberty!* the throng
Of patriots shouted, when great Brutus drew
His sword on Cæsar's spirit!——Is she not
Then sacred, dear? Made sacred by the blaze
Of virtue, that has flashed from age to age
Around her form; and dear by all the blood
Of innocence and beauty, and the tears
Of fond affection, pity, friendship, love,
Offered upon her shrine. There is no cause
For which the mailed hand and glittering steel
Is raised in stern effrontery to heaven,
And the tremendous shoutings of armed hosts
Shake earth's deep confines, save the cause
Of Liberty, can justify vain man:
But she baptizes the mailed brow with glory,
And sanctifies the naked sword, though steeped
Up to its hilt in blood, and gives to war
A holiness and virtue. Tyrants strove
Through many ages and in many climes,
To tread the flame of Freedom from the earth,
By iron hoofs and the stupendous crush
Of marshalled armies: but it still survives;
And, like the phœnix, soars triumphantly
From its own ashes. Wild nature gives
Her spirit forth from all her solitudes,
Where the free lion roams, or eagle soars:
The winds, the thunders, lightning, and the storm;

1 Lucius Junius Brutus. 2 Virginius.

The mountain tops piercing the vault of blue
In their unshackled grandeur; the rude rocks
With forms fantastic shooting to the stars;
The unsubdued ocean, and the depths
Of the immortal spirit, when it bows
Only unto the Deity, gives out
Her essence to mankind. Did'st thou not drink,
Patriot of Scotia,[3] when thy country laid
Prostrate before the haughty Edward's feet,
From these sublime eternal sources—*fire*,
That turn'd thy slumbering dust into a God,
And bade it walk the hills in majesty
Of daring great as Mars. Glorious chief,[4]
Child of the mountain tops, whose arrow took
The whirlwind for its pinion, and found out
The Austrian in the storm. Bolivia,—Thou,
In whom the virtues of the elder world,
Kindle as in a focus to be thrown
In glory o'er the new,—did you not hold
From nature's face a charter of success,
And feel her influence stirring through your powers,
When on the Andes or the snowy Alps,
Your unsheathed weapons glistened in the sun?
Columbia, thou art FREE:—Oh what a power
Of magic hath that word;—Is there a heart
That ever felt its ardour smothered up,
And knows the joy that follows the wild rush
Of the bound spirit into freedom's air,
That finds no rapture in that word?—What eye
That has beheld the prisoner unchained,
And the caged bird let loose in extacy,
Will fail to weep for very joy, to know
That *Freedom's* eagle spirit rears her form
With more than Roman grandeur, o'er a world
Suffused with glory's beam?—Is there a tongue
Accustomed to give glory unto him
Who made man free, can now forbear to praise,
And mingle with the passing winds the sounds
Of gratitude; or with the solemn bass
Of sultry thunder trembling in the clouds,
The diapason note of extacy
In loud hosannas fail to blend?

3 Wallace. 4 William Tell.

SOUTH AMERICA may be said to comprehend, Guatemala, or central America, the Republic of Bolivia, the Republic of Colombia, the Republic of Peru, the Republic of Chili, the United Provinces of Rio de la Plata, or the Republic of Buenos Ayres, with the Empire of Brazil, and the French, English, and Dutch Guianas, Amazonia, Paraguay, and Patagonia.

The chief Islands are, Terra del Fuego, Trinidad, Juan Fernandez, St. Felix, Malpelo, the Falkland, and the Gallipago Isles.

The Capes are, Cape Vela, St. Roque, St. Augustin, St. Mary, Cape Blanco, St. Francisco, and Cape Horn.

The Seas, Gulfs, Bays, &c. are, the Carribean sea, the Spanish Main, the Gulf of Darien. The Bays,--that of St. Georgin, Patagonia, with the Bay of Bonaventura, in Terra Firma, and the Bay of Guayaquil in Peru, are the most distinguished; the Straits of Magellan and Le Maine are also remarkable.

Guatemala is situated between Colombia and Mexico, and is a part of Terra Firma; it has recently acquired its independence. Colombia, which is the most important of all the Republics, including New Grenada and Venezuela, has been recently liberated from the dominion of Spain by Bolivar,[1] who is now President.

[1] Bolivar, surnamed the Liberator, is perhaps the most illustrious character of the present age. One word alone *seems to have* animated him to the most astonishing exertions and daring enterprises, and inspired him with *hope in the* darkest reverses of fortune: more than once

Peru lies on the west coast of America, and was also liberated and formed into a Republic by Bolivar. Chili lies on the south western coast, and is likewise free. Buenos Ayres is perhaps, upon the whole, the most flourishing Republic as regards trade: the empire has obtained a constitution. Amazonia contains but few settlements, and is but little known; and Patagonia, on the coast, contains some settlements of the Spaniards and Portuguese, but the interior has been seldom explored.

These Republics, during the last ten years, have been occupied in asserting their independence; it, consequently, cannot be expected that much has been accomplished relative to the internal improvement of the country while under military occupation. It is, however, gratifying to remark, that the public institutions in most of the Republics have been upheld, and that the popular spirit of the South Americans is decidedly in favour of instruction. In Buenos Ayres there exists an university and ecclesiastical college, a school of moral philosophy, and a central school for mutual instruction, which supplies teachers for the other parts of that Republic, while the national library contains 50,000 volumes. In Colombia there is a school established by order of the government, in every parish,

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his patrimonial estates have been devastated, himself branded as a traitor and an usurper; but he had declared that South America should be free, and that he would never sheath his sword till every hostile Spaniard was *driven from its soil*. This he has accomplished, and *stands at once the* father and the saviour of his country.

amounting in the whole to nearly 1400, while in the principal towns central schools exist, which supply teachers to the provinces. Caracas, Bogota, and Quito have each universities and colleges, while in Chili and Peru the most strenuous exertions are making for the people and the emancipation of the human mind.

During the recent struggles these states have suffered considerably, and their progress has been retarded; although compared with the revolutions of the old continent, the changes in these governments were effected with ease and facility. The spirit of peace seems to unfold her wings as the mind immerges from its darkness; and conciliating measures, like those which for forty years have distinguished the policy of the United States, appear likely to prevail among the South American Republics, which will more than any thing tend to their ultimate happiness and prosperity.

Here must conclude the geographical part of our work, in which we have been anxious to confine ourselves as much as possible to the present moral and intellectual state of the various nations inhabiting the globe; but it is with a melancholy reflection that we must conclude. We have seen that the greater part of this world is still under the yoke of sin, mental darkness, and tyrannical dominion; we have traced the outline of many religions, whose adherents mutually despise and persecute each other; but what is the most distressing to the christian and *philanthropist*, results from the reflection, that *even where we* are taught to believe that t

ligion is at work, crimes are scarcely less fre-
ıent and dreadful than in the wild unenlight-
ıed shores of foreign lands, in which God and
s holy will are unknown; millions upon mil-
ons have been spent by the pious and benevo-
nt, to spread the religion of Christ to every
rner of the earth, but alas! in those countries
hich the glory of the Lord is said to fill, as it
d the temple of old, and which is the focus of
adiation for the gospel, the christian virtues
e lost in the false glare of worldly grandeur,
ıd the love which man should bear to man, ap-
ears to be generally superseded by the love of
ealth and self aggrandizement; in religious
ncerns a rancourous disunion is too general,
ıd unfortunately real piety and virtue is so
rrounded by the hypocrisy of the artful and
signing, that good men almost fear to put on
e outward beauty of holiness, and draw back
ily from institutions to which their presence
uld be an ornament, from the consideration
the ostentatious character they exhibit, and
false motives by which they are governed.
institutions for the benefit of society, are
numerous and magnificent than those of
age or country, and might be supposed to
ed from a people high in the communion
he living God; but alas! so far from this
the case, we find the most prominent of
oiled by petty enmities, unworthy preju-
and their divine objects persisted in, in
nstances, by the spirit of party, rather
the love of God; while worldly interest
seen struggling through them like the

canker in the blossom: it is for him who alone can bring good out of evil, to make all things work together for the general good, by that mighty working whereby he is able to subdue all things to himself; and for the true believer to pray that he will be pleased shortly to accomplish the number of his elect, and hasten his kingdom.

Oh! thou false world, whose fitful glare
Breeds fever in the gentle eye,
Think not omnipotence will bear
For ever with impiety;
Or that His eyes, too pure to look
On evil, can behold the play
Of passion and deceit, or brook
For ever its triumphant sway;
Or that his kingdom comes to thee
Thus swaddled in iniquity.
Nor thou, deceitful scorpion race,
From whom poor worth seems almost driven,
And pity, startled by the face
Of gorgon hate, flies back to heaven;
Among whose throngs wealth spurns in pride,
Meek worth and humble virtue here;
And feels it pleasure to deride
Affection's sympathetic tear:
Where e'en the pure and heavenly glow,
Of nature's love hath long been cold,
And nature's God is left to throw
The heart before a God of gold;—
Ye never yet his spirit knew,
Think not his kingdom comes to you.

No! No!—it comes, that kingdom comes,
Unto the meek and gentle breast,
And while its glorious ray illumes,
The faithful soul would give it rest;
From every turmoil false and vain,
Which nature and the ways of men,
Throw round it like a stubborn chain,
To bind it in earth's dreary den.
Ye that have wept your hearts away,
In this world's cold and chilly gloom,
Like flowers denied the solar ray,
That wither even while they bloom;
And ye that have the world's rude wrong,
With temper and with meekness borne,
Like that delightful bird, whose song
Is sweetest thrill'd above the thorn:
Who shine in hours of darkness bright,
And brighter as the glooms pervade,
As beauteous glow-worms do at night,
More full with every deepening shade:
To you that kingdom comes indeed,
And who shall curb its heavenly speed?

End of Second Part.

PART III.

NATURAL HISTORY.

CHAPTER I.

Introduction--Zoophites, Geology, Deluge--Poetical illustration Theories of Whitstone, Leibnitz, Descartes, Demaillett, Buffon, Cuvier, &c.—Classes of Rocks; Primitive, Transition, and Secondary.—Formation of Soil.—Order of Strata forming the Crust of the Globe.—Fossil Remains, and proofs of the Deluge.

Having described the order of the spheres, and given in a tabular form a general description of the surface of the globe, and the present moral and intellectual state of its inhabitants, we shall now endeavour to present a few established facts relative to the earth's structure, and the substances of which it is composed.

NATURAL HISTORY in its most extended sense, comprehends the whole universe, and is as extensive as nature herself; in a more confined sense, however, it chiefly refers to those three kingdoms of nature, termed the mineral, the vegetable, and the animal. The productions of the first of these are generally found in the *interior parts* of the earth, are produced fortuitously, grow by external secretion, and are only capable of destruction by mechanical force or

chemical decomposition. The productions of the second division are produced by generation, grow by nutrition and the consumption of certain gases from the atmosphere, possess organized structure, and in some few instances irritability and contractility, but are destitute of *sensation*, and are destroyed by death. To the third division, or animal department, is superadded the properties of sensation, muscularity, and volition, or voluntary motion, at the head of which man is placed.

Beside these three kingdoms, there is one whole class of productions, called zoöphites, which in outward appearance resemble *vegetables*, but perform real animal functions, and are as links of connexion in the above named three kingdoms of nature. Zoöphites are animals of the polypus kind, mostly covered with a calcarious crust, differing but little from the shells of lobsters, shrimps, &c., which appears to receive its hardness from different proportions of carbonat and phosphat of lime. These polypii assume a great variety of appearances, according to their arrangement; the same species, however, always assuming the same, or very nearly the same appearances; some are connected together in the forms of a stem and branches, and have their offspring in an egg-like state attached to them; they appear at first sight very similar to sea weeds, but upon an attentive inspection, the naturalist will readily discover the tentacular or feelers of each polypus extended in its search for food, and hastily retracting within its shell upon the slightest alarm: many of this descrip-

tion are found attached to oysters or other shell fish, and often to stones and pebbles which are covered or occasionally wetted by the sea. Other zoophites assume less regular figures, and are much more firm and solid, resembling the production of the mineral kingdom. *Coral* and *sponge* are of this class and may be adduced as a familiar example of the union of the vegetable with the animal kingdom: the former is found in the form of a plant, with a *stony* stem jointed, and the joints, which are longitudinally channelled, united by spongy or horny junctures, covered by a soft porous cellular flesh or bark, and having mouths beset with ovaporous polypii. Sponge is composed either of reticular fibres, or meshes of small spines woven together, and is clothed with a glutinous flesh full of small mouths on its surface, by which it absorbs and rejects water. Having here marked the link of union between the several kingdoms, we may observe, that worms may be considered as the commencement of the animal kingdom, and lead us to insects; the same when simply encrusted in a coat or shell, seem to unite insects and shell fish; while reptiles are united to fish by the water snake, and fish again united to birds by the flying fish; birds to quadrupeds by the bats; and quadrupeds, by the intervention of the ape, seem linked to man; leaving nature's chain all strength, harmony, and almost without a chasm. Having said so much merely as an introduction to natural history, we shall proceed to our subject of Geology, and from thence to Mineralogy, Botany, and Zoology.

GEOLOGY.

Ye heights sublime!
Of rugged granite, which the eagle's claw
Indents not; where the wild chamois stands
In trembling dizziness:——Ye cragged peaks!
That hang in high fantastic masses o'er
The dangerous ravine, turning the bright beam
Of jocund day to the despairing gloom
Of melancholy night:——Ye rock ribbed hills!
And giant forms, that seem as ye could wake
The sleeping thunder:——And ye ocean depths!
With naptha lighted and with coral paved,
The regal courts and rightful palaces
Of unknown slimy monsters:——Aye, and thou
Dark womb of hollow earth!—Dost thou bear
With these fresh witness to the glorious power
And justice of the HOLY ONE?——A voice
Is in the senseless stone, and eloquence,
Full of expression deep and terrible,
Dwells in the compact marble, to declare
The LORD a mighty LORD!
What is the tyrant's arm,
Scattering its millions, throwing down the high
And vaunted places of the proudest ones?—
What is the potent march of iron hosts,
Wading knee deep in blood, 'mid sulphurous smoke
And flashing steel, lit by the crimson glow
Of flaming cities?——What is all the rage
Of man's destroying spirit, or the lust
Of making desolate?——What are these to Thee
And Thy power, Oh! THOU EVERLASTING GOD?

Palaces, and towers, and lofty pinnacles,
Stood peering towards the heavens; and the high thoughts
Of *men were loftier* still:—Guilt had become
A glory to the brow:—There was no man,
Save one, that worshipped God.—The outward form,

The smoking altar, and the gorgeous pomp
Of sacerdotal state; the hymn, the prayer,
The tedious ceremony, were all observed
With sanctimonious rigour;—but *the ways*
Of men utter'd a daily blasphemy,
And seem'd to strike Omnipotence upon the face,
Daring him to the worst.

The deluge came,—
The fountains of the deep were broken up,—
The heavens sent forth their torrents:—Then arose
The bitter wail of thousands;—Kings and princes ran
Astounded to their glittering palace tops,
Lifting their eyes in agony upon
The bloated sky:—The wave came on, and hurl'd
Palace and prince into the angry deep:—
Some sought the mountains, and exhausted toil'd
To gain their summits;—Mothers snatch'd their young
Fierce from the horror quail'd breast—dash'd them down,
And fled:——For sin had burst great nature's ties,
And slain each kindred feeling. Struggling then,
The weak clung to the stronger, and the strong
Hurl'd them down headlong: some did gain the high
And barren peak; but there the lonely vulture
Battled for its last refuge with them,—prey'd
Upon the horror chill'd and haggard brow,
And on the starting eye-ball, till they sunk,
Spent and exhausted 'neath the roaring flood,
Which over them and all the sons of earth,
Save the eight faithful, then triumphant roll'd.

Who shudders not to look upon the earth,
And view the sad remains of that fair world
Whose black and mournful wrecks of former beauty
Are thickly spread:—Beneath our very feet
Huge monsters of the deep imbedded lie.
The haughty peaks that lift above the clouds
Their ice-crown'd brows, bear relics of that world;
And oh! the dashing sea rolls proudly o'er
*Ten thou*sand cities and their multitudes:
Yet shudder not,—the rainbow shines on high
A token still of mercy and of love.

When we cast our eyes over the surface of the earth, we perceive hills and vallies rising in graceful undulations, mountains whose tops pierce the clouds, and rocks of various forms; we find also that two thirds of the globe are covered with water, which is as deep in many parts as the mountains are high.

To investigate the characters of the component parts of the earth, and the various strata which form the outermost crust of the globe, to determine the nature of the soil, and to contemplate the changes which our globe has experienced by inundations, earthquakes, and volcanos, through many ages, strictly speaking, forms the science of Geology.

GEOLOGY may be regarded as a modern science, for until nearly the end of the last century it was little understood; perhaps because Chemistry and Mineralogy, on which it greatly depends, had not made any considerable advances towards their present state.

The uses of Geology, as a science, are manifold, as by it we know that it would be a waste of time to look in one class of rocks for minerals, while in others we may expect to find them by certain outward indications. It teaches the farmer what kind of manure would best suit his soil, in reference to its sub-strata; and the architect who knows only little of this science, will not construct a building to last for ages with a perishable material.

To account for the remarkable changes our globe has evidently undergone, and even to account for its very creation, hypothesis on hypothesis, and theory upon theory, has incessant

been advanced, which tend to shew how insignificant and simple the wisest of mankind appear, when attempting to account for the inscrutable actions of the Deity. Whitston fancied that the earth was *created* from the *atmosphere* of one comet and *deluged* by the *tail* of another. The great Leibnitz, as did also Descartes, conceived the world to be an *extinguished sun*. Demaillett thought the globe to have been for many thousand years covered with water, and that man originally began his career as a fish. Buffon imagined that the planets, including our earth, were struck off the sun in a liquefied state by a comet at the same instant, and that only the outer crust of each, to a very small depth, has yet been cooled. Some have considered the globe as a large animal, and that animals, including man, obtain their subsistence by feeding on its body. In opposition to these vague surmises, how beautiful and clear is the account given in holy writ of the creation, resolving it simply into the will of the most high; and what exalted ideas does it give us of the divine being, in comparison with opinions merely human.

The science of Geology divides the mountains, &c. into two classes: the first is called primitive, or primeval; the second, secondary, or epizotic; an intermediate class, partaking of the properties of both these, are called transition rocks.

Primitive mountains are so called, as they are *supposed* to have experienced no change since the creation of the world. The primitive mountains are generally the highest in any range, and are composed of the hardest materials. The

number of primary rocks usually observed is eight;—1st. granite; 2nd. micaceous schistus; 3rd. sienite; 4th. serpentine; 5th. porphyry; 6th. granular marble; 7th. chlorite schist; 8th. quartzose rock.[1]

The transition series of rocks, which are next in point of antiquity to the primitive, are less lofty than the former; they are supposed to have been formed while the world was passing from a chaotic to a habitable state; they are less perfectly crystallized than the *primitive*, and contain, like the *secondary*, organical deposits, partaking of the nature both of the primary and secondary mountains. They are, slate, flinty slate, grey wacce, sub-crystalline limestone, or common marble. Subordinate or imbedden in the above, are found, gypsum, trap, &c.

Secondary mountains are generally composed of softer materials, and are distinguished by con-

[1] *General Order of the Strata of the Crust of the Earth.* —1. Vegetable mould, black earth, composed of putrified vegetable and animal substances. 2. Alluvium, formed from the ruins of rocks, by the agency of water, consisting of gravel, clay, sand, with bog, beds of peat or wood coal and petrifactions. 3. Fresh water formations. 4. Clay and sand, or pulverized rock. 5. Chalk and marle. 6. Clay and sandstone, formed from the consolidation of sandy particles. 7. Oolite. 8. Lias. 9. Various Clays. 10. Coal formations, containing organic remains of vegetables. 11. Red Marle and sandstone. 12. Mountain or transition rocks, and limestone, in which are organic remains *imbedded*. 13. Old red sandstone, rock salt, gypsum. 14. Green, stone trap, and greenstone slate. 15. Clay and slate-*containing organic* remains of fish, with talc in flat *smooth laminæ*, or plates. 16. Mica, slate, with beds *of marle and stone*. 17. Gness, with beds of granular *or primitive limestone*, composed of crystals of carb

taining the fossil remains of organized vegetable and animal substances, which prove them to have been acted upon by certain changes which our planet has undergone. This division contains twelve varieties, all usually found in the British islands; namely, 1st. grauwacke; 2nd. siliceous sand-stone; 3rd. limestone; 4th. aluminous schist or shale; 5th. calcareous sand-stone; 6th. iron-stone; 7th. basalt or whin-stone; 8th. bituminous or common coal;[2] 9th. gypsum; 10th. rock salt;[3] 11th. chalk; 12th. plumb-pudding stone.

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nate of lime, and called statuary marble. 18. Granite, the base of the whole; whose constituent parts are quartz, feldspar and mica.

[2] Coal is found to exist in strata of various degrees of thickness, occurring over each other separated by clay or stone. Coal is usually divided by Geologists into brown and black; the former, called also wood coal, is an alluvial production apparently formed by vegetable matter, such as trees, &c.; in this may be observed the forms of roots and the fibre of the wood apparently carbonized and consolidated, the upper surface appearing distinctly marked, while in the lower ones the coal is more compact, of a black colour, and nearly as heavy as the common mineral coal. Black or mineral coal contains some portion of vegetable matter, mixed with charcoal, bitumen, stone, and that earthy matter which forms the ashes after combustion.

[3] Rock salt has been thought to be produced by the evaporation of sea water; but as in sea water a large portion of muriate and sulphate of magnesia is found, such a supposition cannot deserve much attention. In many places rock salt forms hills of considerable height; at Cordova, in Spain, it rises in one solid mass 400 feet *above the* earth's surface; and in Peru, accompanied *with sandstone* and gypsum, it is found 9,000 feet above *the level of* the sea.

Primary and secondary rocks occur in a certain determinate order, in different layers, encircling the globe like the coats of an onion. They are formed universally over the earth's nucleus, in a regular series, the same in every part of the world. The secondary rocks lie always on the primary, the lowest of which is usually grauwacke; often upon this, lime-stone or sand-stone is found. Coal mostly occurs between sand-stone. Basalt often exists above sand-stone and lime-stone. Rock salt generally occurs associated with red sand-stone and gypsum.

The constituent parts of all rocks and stones are very few, consisting merely of the four earths, silex, lime, clay, and magnesia, with the oxide of iron. These compose nineteen parts in twenty of the external material of our planet. Carbon and sulphur are, however, abundant in the mineral kingdom.

The simple minerals are formed from the above earths, and compose the compound primary rocks, quartz, feldspar, mica, talc, and horn-blend. Quartz is one of the hardest minerals that compose the mountain masses; it affords sparks with steel, and is easily broken with the hammer. Crystals of quartz, commonly called rock crystal, have different degrees of transparency; the blue varieties are amethysts.

Feldspar is not so hard as quartz, from which it is also distinguished by its being composed of thin laminæ or plates; some of the specimens are beautifully irradiant with colours.

Mica has a very glittering appearance, and is *brown in the mass,* but yellow and transparent

when separated into laminæ; it is commonly called muscovy glass.

Hornblend appears to connect the primary rocks with those of volcanic origin; it is of a black or dark green colour, heavier but less hard than quartz and feldspar; scratched with a knife its colour is light green: it yields a bitter smell when breathed upon, and melts easily into black glass.

From the union of two or more of these, including limestone, all rocks, simple or compound, may be composed.

The internal constitution of the earth is but little known, as the excavations that have been made do not exceed 3,600 feet. The first layer that presents itself is usually vegetable mould, which is the support both of animals and vegetables; these draw from it their nutriment, are resolved into it, and are again raised from it in an increasing circulation. Earth, gravel, and vegetable mould, are doubtless formed from the decomposition of rocks, in which electricity has a remarkable agency, as electrical power is constantly exhibited in the atmosphere. Chemical and mechanical means also unite in the pulverization of rocks. In the first instance, the varying temperature and the chemical properties of atmospheric air, the carbonic acid of which attacks and efflorescences the limestone, while the oxygen unites to the metallic parts and oxides them, which creates a separation; these particles *thus loosened*, by their common gravity fall *down*, and in their descent are by friction de*prived of* their projecting angles and gradually

ground down to powder, and settle in the lower parts of the earth's surface; by this agency precipituous rocks are gradually made gentle slopes, lakes are filled up, and islands are formed at the mouths of great rivers. As soon as a bed for vegetation is thus prepared, the seeds of lichens, which are constantly floating in the air, gradually prepare a soil capable of supporting mosses and heath; the death and decay of these afford food for a more perfect species of vegetable, and lastly, a soil is formed in which the trees of the forest can fix their roots, and which affords abundance of vegetable sustenance for man and animals.

In addition to the great changes that have taken place in the earth at a former period, there are very remarkable changes still going on, from the agency of air, fire and water. The action of the air and the varying temperature of the atmosphere, (as before stated), upon the masses of rock, gradually facilitate their destruction, while the rain washes down their pulverized particles to blend with the soil: the harder portions resist the longest, and gradually attain sharp and projecting features, while in other places where the substance is softer, furrows are formed, which gradually deepen into chasms, through which rivers rush with impetuous violence. The sea is also continually making inroads on the land in one part, and receding from it in another: many islands which were formerly places of considerable notice are now little more than bare *rocks, while the* subterraneous fires and the *action of volcanoes,* have not only destroyed towns,

villages, and large tracts of country, but, through their agency, new islands in various places have suddenly arisen from the depths of the ocean, being in a few years afterwards covered with soil and vegetation.

The limits of this work will not allow us to enter further into Geology as a science; the more interesting facts connected with it we think it right, however, to lay before our readers. Upon an examination of the various strata which form the crust of the globe, we are led to infer that every part of the dry land was once covered by the ocean, by the fossil remains of vegetables, zoöphites, and animals which they contain. These relics of a former world, are principally found in calcareous substances, of which the limestone mountains in Derbyshire which are elevated above 2,000 feet from the level of the sea, afford abundant specimens, consisting of zoöphites, shell fish, and marine animals. The mountains of the Pyrenees at an elevation of two miles, are covered with calcareous rocks, containing also impressions of marine animals. In the Andes, they have been observed by Humboldt at the height of 14,000 feet; and in southern countries, under beds of clay coverin chalk, the bones of the elephant and rhinocer are frequently found.

Among the fossil remains found in the Briti empire, although bones of the elephant and c codile are frequently found, yet none are m *calculated to* excite astonishment, than the e *mous stag horns*, which have been dug v *various parts of* Ireland, and are at leas

times the size of those of the stag of the present day. In France, various remains of the crocodile and elephant are frequently found; in fact, there is scarcely a part in the known world that does not afford similar specimens in abundance, mixed with the bones of other quadrupeds, such as those of the ox, horse, &c. America is prolific in these fossil remains, and bones of one of the most stupendous animals known, (the Mastodon) have been found in various parts, particularly on the sides of the three great chains of mountains, the Alliganys, the North Mountains, and the Blue Mountains, in the interior parts of Pennsylvania and Carolina; but the most wonderful and perfect organic remain that has yet been discovered, was found projecting from an ice bank near the mouth of a river in the north of Siberia. This has been generally called the Siberian Mammoth, and was when first discovered, in a state of preservation truly remarkable, as the greater part of the flesh remained, with the brain, &c. and even the pupil of the eye was clearly to be distinguished. Upon examination, it appeared to afford a proof, that this animal also, had belonged to a race of elephants now extinct, inhabiting a cold region; it was also evident that this enormous animal must have been frozen up by the ice at the moment of its death.

It may be added, that fossil shells at the greatest elevations, and many hundred miles from the sea, of species inhabiting both salt and fresh water are frequently discovered, while forests imbedded in coal, or vast multitudes of

the trunks of trees, and impressions of their branches, leaves, and fruit, which although found in cold climates indicate them to have been indigenous to hot ones, undoubtedly refer to a former condition of the globe, or to some grand catastrophe which has brought to northern latitudes, the vegetable productions of tropical climates.

The sagacious naturalist Cuvier has attentively examined these remains from different parts of the world, and in the animal portion observed characteristic variations of structure, proving that they belong to animals not now existing on our globe; and seldom are any of the various zoöphites and shell fish found in calcareous rocks discovered in our present seas: the inference to be drawn from these circumstances is, first, that our globe has undergone many vast changes; secondly, that these changes have been produced by water; thirdly, that earth's surface has been fractured since its consolidation, and that its axis is materially changed; and lastly, that the whole of these appearances afford evident proofs of a universal deluge. We thus see that science so far from invalidating scriptural testimony, when prosecuted with a proper spirit tends to confirm it, and that the human mind finds in its sublime researches something that continually brings the omnipotence of the Deity into view.

MINERALOGY.

Spirit of love! Spirit of love!—the soul
Of Deity on earth:—the soul of soul,
And essence of the universal weal;
Encompassing, pervading, binding all
The elements in one harmonious law
Of beauty and sublimity. 'Twas thou,
Bright aspect of the Holy One, didst move
Upon the dark chaotic waters, ere
Matter caught glory from the golden sun;
And beauty sprung in rapture from the deep
With the new earth all smiles: while all the host
Of heaven, the stars, the planets, and the range
Of suns unnumbered sung for very joy,
And mingled with the everlasting spheres
Triumphant melody. Yes, it is *love*,
Boundless eternal love, that springs from Thee,
Almighty Father, on the ruddy wings
Of morning, with the blithe young lark in joy;
Or on the evenings tranquil holiness.
Giving the parting fascinating beam
Of the bright sun a milder charm, and pouring
To the wrong'd heart a balm, and to the spirit
Thoughts that eternity cannot annul!

The depths of nature, and the womb of earth,
The peerless blue of heaven, in which the soul
Expands as doth the circle in the lake,
All eager to embrace infinity. The stars
That draw us proudly to their vestal heights,
As the bright glow-worm wins his wandering mate,
Give forth their everlasting tokens still
Of love: and all that sheds a fragrance on
The gentle gales of spring, and all that give
Their virgin blossoms to the summer sun,
From that meek flower low hidden in the sod,

That lifts a sky-blue eye to gaze at heaven
In heaven's own likeness, to the lofty pines
Which tune great nature's ever living lyre,
To listening lowlands, from the rugged tops
Of mountains, where the eagle builds her nest,
Above the range of thunder. Ocean, thou,
On whose dark emerald breast sparkling with gold
The sun-beam wantons with the dolphin: earth
Sending up incense in the rosy cloud,
And rapture on the gale,—do ye not speak
Of boundless, glorious love, throughout the whole
Of your vast stores?—And thou, fond soul of man,
Although confined in this cold prison house
Of sluggish clay,—*thou* canst speak of love
From all those powers of high capacity,
Those deep perceptions of the beautiful,
And those high efforts which give out the blaze
Of that strong immortality within us,
As the dull stone when smote its latent fire:
But *most* when contemplating in a high
And holy extacy that work of love,
Which calls thee to a forfeited estate,
And opens wide heaven's portals to restore
Thee to the bosom of thy God!

CHAPTER II.

MINERALOGY is that department of the science of nature which makes us acquainted with the characters of minerals. The word mineral in its strict sense merely denotes such substances as are found in mines, but is generally applied to all those substances which form the crust of the globe we inhabit, not included in the *vegetable* and animal departments.

There are several systems of mineralogy; the *modern systems* of Bergman, Kirwan, Chaptal,

Schmeisser, and Babingdon, are the systems most consistent with nature: in these, minerals are classed according to their external characters and component parts; the component parts, or principles of minerals, afford the great outlines for classing them as species and varieties, and their external appearance will always point out the experiments which will determine their proper place: by these means they are described with so much precision as to be easily recognized whenever they occur.

Minerals, although unorganized bodies, have origin, increase or growth, and are subject to a dissolution of parts. Their origin and increase is ascribed merely to an accumulation of homogeneous or similar particles from without, called cohesion: or by the *separation* of the solid from the fluid parts, which attract each other according to certain laws, and is called crystallization, of which only certain minerals are susceptible, and which are with some few exceptions resolvable into six principal forms,—the tetrahedron, cube, octahedron, parrallelopiped, rhomboïdal, dodæcaëdron. All mineral productions are comprehended in four classes,—the earthy, the saline, the inflammable, and the metallic ores.

The earthy minerals comprehend all those deriving their qualities from the earths, and are divided into families, according as each particular earth predominates: the minerals of this class are not inflammable in a low temperature, without smell or taste, in general brittle and *disposed to crystallize. They are either silicious, in the form of pebbles, gravel, sand, &c.*

or are calcareous, as limestone, chalk, spar, marble; or argillaceous, as clay, fuller's earth, slate, &c.; or barytic, as the baroselenite or ponderous spar. In these compounds, when more than one of the earths are found, the earth which predominates always marks its distinction. Most of the precious stones are compounded of one or more of the other earths, lime, alumine, magnesia, and at times a small portion of iron, are united to a portion of pure quartz, or to silex, in a crystallized form, from which union results the onyx, opal, garnet, &c.; while alumine, magnesia, and chromic acid, compose the ruby; and the chrysolite appears to be a compound of lime and the phosphoric acid.

The saline minerals comprise all the combinations of acids with alkalies that exist in the mineral kingdom, as saltpetre or nitrate of potash, common rock salt or muriate of soda, and sal ammoniac or the muriate of ammoniæ; these are characterized by being moderately heavy, white, sapid, soft, and slightly transparent.

Minerals of the inflammable class are light and brittle, but mostly opaque, seldom crystallized, and do not feel cold: this class includes sulphur, resin, bitumens, such as mineral pitch, coals, &c. Graphites, which are true carburets of iron, one of which is black lead or plumbago, and all combustible bodies, except metals and the diamond.

The metallic class contain many genera, characterized by great specific gravity, opacity, and lustre, called metallic lustre; these genera are divided into species, sub-species, and varieties,

ling as they agree or differ in shape, color, re, and hardness. From minerals of this all metals are extracted.

METALS form a most important class of na- bodies, and according to the present clas- ion amount to forty; in consequence of ving been recently ascertained that many ances, which were formerly treated as sim- arths and alkalies, are oxides of certain s, by their capability of being resolved ir metallic state, by the agency of a power- oltaic battery: the earths which are thus ible, are lime, magnesia, barytes, strontites, ne, glucina, zirconia, silicia, and yttria; lkalies are, potash, soda, and ammonia, found among the metals, under analogous s. The whole of the metals now enumer- are called—

ssium	Tin	Columbium
um	Iron	Cerium
m	Plumbago	Palladium
tium	Antimony	Iridium
um	Bismuth	Rhodium
nesium	Tellurium	Mercury
inum	Cobalt	Silver
num	Copper	Gold
nium	Nickel	Platinum
um	Uranium	Arsenic
um	Osmium	Molybdenum
ganese	Tungsten	Lead and
	Titanium	Chronium

e *common* metals, by their fusibility, mal- *ity, hardness,* and durability, are of the

most importance to mankind; these are, 1st.

Platina or platinum, which was first ascertained to be a perfect metal by Scheffer, a Swedish chemist, in 1752, and soon became subject to the experiments of all the chemists in europe, who determined it to be equal in most of its properties to gold, but in others very superior. Platina is generally mixed with iron, and is therefore magnetic. It is ductile, and may be hammered into plates or drawn into wire. Platina ore is generally mixed with four other metals, osmium, irridum, rhodium, and palladium, and is found in the mines of South America, and in the silver mines of Guadelcaval in Estramadura.

Gold is always found in a metallic state; it is generally met with in grains, mixed with the sands of rivers; or in rocks, where it is found in leaves or ramifications, adhering to quartz and other stones. It is the heaviest of all metals excepting platina. All the known parts of the earth afford gold, but the greatest quantity is obtained from the mines of Peru and Chili. The applications of gold to the useful and ornamental arts, are too well known to need particular detail.

Silver is often found native, and also combined with lead, copper, mercury, cobalt, sulphur, &c.; when found in the metallic state, it appears in grains or leaves; it is of a very brilliant white. There are silver mines in most parts of the world, but the largest quantities come from Peru and *Mexico.*

Iron is the most universally diffused metal

throughout nature, and is found in combination in every part of the mineral, vegetable, and animal kingdoms; it has hardness, elasticity, and ductility. It is very difficult to fuse, and soon rusts or oxydates when exposed to the action of water or the atmosphere. Iron is fused from the ore in large furnaces, and made to flow into moulds of sand. Crude or cast iron is in three states, white, grey, or black, according as it contains a larger proportion of carbon, an exact proportion of oxygen, or a larger proportion of oxygen. To render iron malleable, it is obliged to be kept in a state of fusion for a considerable time, during which it is stirred and kneaded, that the carbon and oxygen which it contains, may unite and pass off in the form of carbonic acid gas; it is then beaten with hammers and pressed with ponderous rollers, which force out its other impurities, when it becomes fibrous and ductile, and is called forged or wrought iron. Another state to which iron is reduced is called steel, by being exposed to a heat in contact with carbonaceous substances, which unite themselves with it. Steel is heavier and more malleable than wrought iron; it acquires its hardness and elasticity by being tempered, which is performed by its being heated, and suddenly cooled by immersion in water. Steel is too well known to need any description.

Copper is a little harder than silver; it is sometimes found native, but in small quantities; it is generally met with in the state of an oxide. Copper is mostly found in Sweden; it is ductile, and the most sonorous of all metals.

Tin is harder than silver, and softer than lead; it is very flexible, and the most fusible of all the common metals except mercury.

Lead is a coarse heavy metal, and is chiefly procured from certain ores, in which it is combined with sulphur. It is easily oxided, and increases in weight by exposure to the air; when exposed to a heat with an access of air, it fuses, and is oxidated on its surface, which oxide is called the oxide of lead; this oxide exposed to a stronger heat is converted into *massicot*, and this exposed to a still stronger degree of heat, assumes a red colour, and is converted into red lead, or minium. Lead forms alloys for other metals used as solders, and is employed much in the arts.

Mercury always appears in a liquid state, excepting when the temperature of the air is 39 below 0° of Fahrenheit, when it assumes a solid form. Mercury is usefully employed in extracting gold and silver from their ores, and is invaluable in pharmacy, where it is used as calomel, called the sub-muriate of mercury, which is produced by its being first precipitated in sulphuric acid, and afterwards drawn over the fire in a retort; or as corrosive sublimate, called oxymuriate of mercury; or mixed with sulphur by trituration, called Ethop's mineral; or with a confection by trituration likewise, called the blue pill.

Zinc, vulgarly called spelter, is hard, white, and brilliant. It has lately been discovered to possess great malleability and ductility, in a *certain temperature*. Zinc dissolves freely in *sulphuric acid*; and the solution, when crystal-

lized, forms the sulphate of zinc, the white vitriol or white copperas of commerce. This metal, next to potassium and sodium, (magnesia always excepted), is the most susceptible of oxygen. The tinning of common pins is effected by the affinity of this metal. In the atmosphere, mixed with three parts of nitre, zinc burns with excessive splendour.

Plumbago, called also graphite or carbonet of iron, is found very plentifully in Barrowdale, in Cumberland; it is infusible, but will burn in a flame, urged by a current of oxygen gas. Crucibles and retorts are made of this substance, which will bear almost the strongest heat.

Antimony has a brilliant white colour with a shade of blue; when melted it emits a white flame, while cooling it slowly crystallizes in octahedral crystals. It is very little changed by exposure to the air; steam passing over it in a red hot state, is so rapidly decomposed as to occasion a violent detonation. Antimony is of great service in medicine, and is used as an alloy in printer's type, metal, small shot, mirrors of telescopes, &c.

Bismuth is a yellow and white metallic body, usually found in silver and tin mines. It is brittle, and cannot be drawn into wire. It fuses at 476° and crystallizes in cubes.

Arsenic is of a grey colour, brittle, and harder than copper. It is a highly inflammable metal; it proves extremely corrosive to animals, so as to become a violent poison: it soon loses its metallic lustre in the air, and becomes black. Arsenic is often found native; when combined

with sulphur it is called orpiment. Arsenic is employed by dyers, and is used as a flux in glass-houses.

Cobalt is a grey inclined to a pink coloured metal, brittle, pulverizable, magnetic, and as difficult to fuse as iron; it yields fine colours to the painter, and for sympathetic inks. A precipitate of cobalt by a potash lye from nitro muriatic acid and nitrate of zinc, yields a beautiful green. Powdered cobalt inflames if thrown into oxygenated muriatic acid, called now chlorine. Oxyd of cobalt, when freed from arsenic, is known under the name of zaffre.

Manganese is a light grey metal, very brittle, and difficult to melt; it absorbs oxygen from the atmosphere so rapidly as to change from white to red and black oxides. It is vulgarly called glass maker's soap, from its freeing glass from its green or yellow tinge. The black oxide of manganese is found very generally and in great purity near Exeter; this is the substance used for obtaining chlorine, used in bleaching, from sea salt. Manganese is found only in combination.

Nickel* was discovered by Cronstedt, a Swedish mineralogist, a few years ago. It is of a reddish colour, not very malleable, and very difficult of fusion. The oxide of Nickel gives a fine hyacinth colour to glass, for which it is used in making artificial jewels.

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* *The other* metals are either not sufficiently known, *or not of* sufficient importance to be embodied in these *outlines.*

BOTANY.

Oh! Holy Nature! handmaid of a kind
And bounteous Deity:—Thou givest us all,
With unrepining hand thou givest us all;
While the base world deceives, betrays,
And mocks us with vain show:—Thou art our mother,
And knowest all our many wants, and holdest
The breast of nurture with a smile of love,
Pressing us to thy bosom in our tears,
And givest us gentle slumber, and the kiss
Of peace upon our eyelids. Happy he
Who trusts, and knows thee, and can follow thee
With admiration through the varied year,
Of sunlight and of shadow, glory, storm;
For there's a spirit breathing through the whole
Of thy fair works, that finds its partner, love,
Within the heart of man; that calls the soul
From its dull sleep, and bids it ride the clouds
In extacies uncloying: such hath power
To bring up wither'd hopes to light and life,
And holier thoughts renew. Spring doth whisper forth
E'en with the violets' odour, happy thoughts
And kindred aspirations; such as seem
To make the heart bud out again afresh,
With hopes that are eternal: summer's sun
In brightest glory lighting up the meads,
The sombre grove, the playful waterfall,
And the sublime cascade with rainbow tints,
Smileth away the sadness of the heart,
And makes its beatings joyful; and the airs
In which the harvest hymn goes up to heaven,
Bear the rapt soul in their melodious swell,
And fan to flame within the bosom's care
Those fires which winter's frosts can never kill!

CHAPTER III.

Definition of Botany, its importance.—Of the pith of trees—the wood—the bark—cellular tissue—the roots—vasicular system—the buds—the leaves—nutrition of plants—the products of plants.

BOTANY is a science which includes the history and geography of the vegetable kingdom, the structure, functions, and uses, with the arrangement, classification, and systematic nomenclature of vegetables.

The study of botany is not merely an elegant amusement, or a beautiful display of the economy established by an all-wise and bountiful Creator, in the vegetable department of natural history, but is of very important service to mankind, from the varied uses of plants in food, raiment, medicine, and the arts.

A knowledge of botany enables us readily to distinguish between wholesome and deliterious vegetables; for a person skilled in this science, on beholding the flower of a plant whose calx is a double valved plume, with three stamen, will be certain that it is of a farinaceous quality, and may safely be used for food; or should a flower with twelve or more stamen, all inserted in the internal side of the calx, come under his inspection, he can pronounce its fruit to be wholesome; at the same time, should he be presented with a plant, whose fruit is of the berry kind, having a flower with five stamen, one pistil, one petal, he will not hesitate to declare it poisonous.

Vegetables are organized substances, deriving nutrition from the earth by means of roots, and *breathing* by their leaves; they possess life, growth, in some few instances contractility, and are subject to disease and death.

All plants, however different in structure, are composed of solid and fluid parts, and in their structure generally exhibit a fibrous and hard mechanism, which gives support to the other organs; this, upon examination, is found to be composed of an assemblage in which exquisite art and design is displayed, of fibre, membrane, tubes, and vessels. In the centre is found the pith, which is thought to be the seat of vitality in the plant; next to the pith lies the wood, surrounding these the bark.

The pith is composed entirely of cellular tissue, which is at first filled with watery fluid; this being evaporated, air enters in its place, and the cellular tissue usually becomes dry before the first layer of wood is perfected, except in the younger shoots, where it retains its moisture. In many herbaceous plants the pith is merely the internal lining to a hollow tube.

Between the pith and the bark lies the solid substance, usually called the wood, which appears to be formed of concentric layers; the interior coatings or rings of which are harder than the exterior, being older, and are of a more firm and close grain; the hardest of these form the wood, properly so called, while the softer external rings constitute what workmen call the sap. *The woody* part is formed of fibre, more *or less longitudinal*, connected together by a

cellular tissue, interspersed with vesicles, communicating with each other, which diminish gradually towards the centre. The cellular tissue is found to consist chiefly of cells, more or less regular, resembling those of a honey comb, varying however in different parts of the same plant; some of them are globular, some of them have a twelve-sided figure, and others appear as six sided figures transversely elevated, or as ranges of small cylinders. The size of the cells varies in *different parts* of the *same* plant; in some plants this difference is very remarkable, it being found that the vessels are at times so large as to be visible to the naked eye, while in another part, they are so minute as to require a million to cover a square inch of surface.

Interspersed through the wood, and connected by the ligneous or woody fibre and cellular tissue, is found the *vesicular* tissue, which bears a great analogy with the glandular and lymphatic vessels of the human body, as its vessels contain the various vegetable humours and secretions. The vesicular tissue is composed of three differents kinds of vessels; the sap vessels contain the sap, which may be compared to the blood of animals, as from it the several organs extract the different juices, and elaborate them in a proper manner. These vessels chiefly occupy the middle of plants and trees, rising perpendicularly, though with deflections sideways, so as to communicate with all the parts of the vegetable, by conveying the sap into the utricles *or reservoirs* for the nutritive juices, which is *accomplished* by the agency of peculiar vessels

provided to separate the various juices, and to preserve them, without suffering them to mix with the general mass of the humours. Thus the same vessel, and frequently the same organ, contains juices of different natures, and greatly differing in colour and consistence.

The Bark is the external covering of plants, and performs the same office to them that the skin does to animals; but it is more important, inasmuch as it is by its agency that the principal functions of vegetable life, such as nutrition, digestion, the secretions, &c. are performed. It comprehends four very distinct layers or parts, the epidermis, the cutis, (inner of thick skin), the cellular integument, (or covering), the liber, or inner bark.

The *Epidermis*, or the external covering, is a thin membrane, commonly transparent or smooth, and is formed of fibres that cross each other in every direction; when destroyed it grows again, but is then strictly adherent to the rest of the bark, so as to form a kind of cicatrice. The epidermis extends over the surface of every part of a plant, from the spongy fibril of the root, to the delicate petal of the flower, and even to the fruit; it is furnished in its extension over leaves, and in some stems, with extremely minute vessels, which spread over it like net-work, the form of the meshes differing in different plants, but all terminating in spiral vessels at the edge of the leaf. The epidermis is here a distinct organized membrane, that gives free passage to moisture, and both exhales and absorbs vapour, and appears to enter the organic pores as a

lining membrane. The epidermis is probably intended for the protection of the cellular tissue, from the direct action of the atmosphere. The hairs, prickles, and glands which appear on the stems and leaves of plants, are merely extensions of the cellular tissue, covered by the epidermis.

The *Cutis* consists of two layers, the outer of which is the pellicle or epidermis already described, and the inner a composition of transverse cells, which stretch betwixt the epidermis and the cellular integument; but this structure varies in different plants.

The *Cellular Integument* lies under the cutis, and is analogous to the rite mucosum of animals. It is composed of oblong hexagonal cells, ranging vertically: and its texture consists of vesicles and utricles so very numerous and so close together, as to form a continued covering. It is among these glands, that the work of digestion seems to be performed; and the *product* of this elaboration, is *afterwards* conveyed through the whole vegetable, by vessels propagated through all its parts, and communicating even to the medullary substance or pith, by conduits passing through the body of the tree, crossing the ligneous strata. In this net-work it is that the colouring matter of vegetables is developed: the light, which penetrates the epidermis, concurs in enlivening the colour; and it is from this reticular substance, that those various products of the organization are thrown off, or excluded; which may be considered as the *fæces of the* vegetable digestion.

The Liber, or inner bark, is of a whitish hue,

and the texture fibrous to the naked eye; but when examined through a magnifying medium, it seems to consist of bundles of longitudinal fibres, running in a waving direction, and touching each other at certain points, so as to form oblong meshes. These longitudinal fibres, under a powerful microscope, are found to be fasiculi of returning or entire vessels, situated between the cellular integument of the bark and the wood, and divided into meshes by the medullary rays (which are those diverging lines seen by the naked eye running from the centre to the exterior of the wood) and which push between these fasciculi, to reach the cellular integument. The whole of the cells of the liber contain secreted fluids; and it is this portion of the bark that yields the various products, which render certain barks useful in medicine and the arts.

BOTANY.

(Continued.)

Scorn not fair Nature's votary, for he
Connects her glories with the hidden things
Of a celestial world; takes from the earth
In greenness or in blossom, or when bronzed
By the autumnal gales, or silvered o'er
By winter's hoary breathings, morals, thoughts,
Comforts and sweetest musings. He who said,
"Behold the lilies of the field" ne'er gazed
Upon his father's works without a smile.
There dwells within the rugged woods no wrong,
Hatred and envy, spite and malice hold

No citadels in solitude. Though rocks
And mountains pile in inaccessible
And haughty mightiness, yet still the music
Of that sweet bird that soars upon the morn,
Is heard upon their barrenness; for nature
Hath something still to soften and subdue,
And all those aspects of ferocity
She wears in storm and tempest, serve to fill
The mind with high emotion, sweeter far
Than our most dear successes. Man might be
Happy, were he to dwell with her alone,
And drink her radiant smile from year to year,
Until she clasped him gently to her breast;
But *happier*, when by love of wisdom led,
He makes her as a strength'ning lens to sight,
And through the medium, although dim, can view,
Some shadow of his Deity, and by
Such visions humbled and exalted ask,
For his good spirit, full of faith and love.

CHAPTER IV.

Of the Root—its Structure and Functions—Buds, Germs, &c.—Leaves and their Functions—Nutrition of Plants—Produce of Plants.

A most important appendage to plants is the root, which generally attaches them to the soil, and draws the nutritive juices from the earth for their support, by means of sponglets, which are oblong soft spongy bodies, situated only on the fibrils.[1] Roots are either annual or living for

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[1] When examined under the microscope, these sponglets are found to consist of a porous cuticle, enclosing a circle of hectagonal cells, surrounded by vessels which open into those of the fibril. By the *aid of these* sponglets, it appears that the fluid is imbibed by the plant, through the cuticle, aided by

one season, as in barley; *Biennial*, which survive one winter, and after perfecting their seed, perish at the end of the following summer, as wheat: or *Perennial*, which remain and produce blossoms for an indefinite number of years, as those of trees and shrubs in general. Roots may be divided into three parts, the caudex the stump body or knob of the root, which is often divided into branches; the rootlets which issue from the caudex and branches; and the fibrils occupying the top and sides of the rootlets. Roots sometimes consist entirely of fibres, as in many herbs and grasses may be observed; sometimes they creep horizontally in the ground, throwing out numerous fibres; sometimes they are spindle-shaped as in the carrot and radish, with thready fibres attached; sometimes stumped as in the primrose: sometimes tuberous or knobbed as in the potatoe, bulbous as in the crocus, or granulated or having a cluster of little bulbs or scales connected by a common fibre, as in the saxifrage.

The Roots of Trees very closely resemble the stem in structure, but in herbs a remarkable difference is found; when the root is annual the

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electrical influence; and the cells swelling, push the fluid into the vessels of the fibril, through which it rises, forced upwards by the impulse giving to it by the continued imbibing of the swollen cells. Some families of plants, instead of this capillary fibril, furnished with sponglets on the rootless, have a spongy knob at the upper point of the root; and in some floating *plants*, as duckweed, there is a small coif or *hood at the* extremity of the root.

caudex consists of a cortical, and thick cellular bark, which constitute a large proportion of the diameter of the root, and a central part composed of oblong cells and vessels disposed either in separate fasciculi in rings or in rays. The biennial root in its first season, consists of a cortical and thick cellular bark, surrounding a large central part, composed of short hexagonal tubes. Perennial roots are still farther varied, and are either composed chiefly of tubular cells symmetrically arranged, or of common cellular tissue.

Of Buds, Germs, &c.—Buds or germs enfold the embryon branch, and are in most instances guarded by scales, thorns, &c. All branches proceed from germs, formed in the earliest enfolding of the parts in which they appear; for in the twig yet inclosed in the bud, the rudiments or germs of branches to be formed upon it, can be perceived with their parts, vessels, and organs. Before organization commences in the germs, the embryon branch is an insulated vesicle, connected with the parent merely by cellular matter, till it gradually incorporates with and becomes a prominent part of the parent plant, where it remains even after organization has commenced, still insulated, till circumstances occur, favourable to its protrusion into a bud: when protruded, it contains the leaves, &c. folded up, or applied to one another in such a manner, as to occupy the smallest possible space; these being in a state of great sensibility, *and feeling* the first warmth of the sun, their *vitality is* roused into action, and the shoot

gradually swells, till bursting the inclosing scales, it pushes into the light and air, unfolding its leaves successively as it advances, with the blossom, and afterwards the fruit.[2]

Of the Leaves.—Leaves are composed of three textures, a vascular, a cellular, and a cuticular tissue. The cuticular system is the most interesting part of leaves. The cuticular covering is composed of two distinct parts; first, the epidermis already described; secondly, the cutis, which lies immediately beneath it, adhering to it very firmly, and consists of a vascular network, laid upon a layer of air cells; this network is made up of lymphatic vessels, the meshes of which assume various forms in different plants, but maintain always the same form in the same plant. This cuticular layer is perforated with organic pores or slits, which are found on the inferior surface or disc of the leaves of trees and shrubs, and their size, form, and number vary very considerably. The functions of these

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[2] There are various appendages to the herbage of plants, all of which are comprehended by Linnæus under the term fulcra, props or supporters; but this term cannot be said to be applicable to many of them. They may be thus briefly enumerated; *stipula*, a leafy appendage to the leaves, stalks, &c.; *bractea*, a leafy appendage to the flower, &c.; *spina*, a thorn proceeding from the *wood*; *aculeus*, a prickle proceeding from the *bark*; *cirrus*, a tendril intended sometimes to climb and to serve as a support; *glandula*, a small tumour, secreting a sweet resinous and fragrant liquor; *pilus*, a lace which includes all bristly *and woolly* excresences, some of which *discharge a poison*, as in the nettle.

apertures appear to be exhalatory and respiratory, and answer to the lungs of the human body, as they are admirably adapted for admitting air into the substance of the leaf,[3] to bring it into contact with the juice contained in the cellular vesicles, for the production of those changes which the sap is known to undergo in the leaves; and although the fact cannot be demonstrated, it has been reasonably supposed that each orifice possess the power of contraction and dilation. From the examination of their structure, the importance of leaves in the vegetable economy may be readily conceived; the sap is carried by them into one set of vessels, is there spread out and exposed to the action of air and light, and exhales its superabundant water; and having undergone by the influence of those agents, aided by an electro-chemical power, certain changes in chemical composition, it is received into another set of vessels, in order that it may be conducted downwards, and distributed in the cortical cells, depositing there the various secretions requisite for the nourishment, health, and preservation of the stem and root; the cuticular system of the leaf is admirably adapted to aid these processes, by its transparency, its vesicular texture, and its respiratory pores.

[3] The heedless observer of the leaf is little aware of the wonderful operations going on in its delicate substance; it appears that the sap is carried into the leaves, for the purpose of being acted upon by air and light, with the assistance of heat and moisture, from *whence it* is returned by appropriate vessels, not into *the wood*, but into the bark.

The leaves of plants are generally formed to present a large surface to the atmosphere, and have a natural tendency to present their upper surface to the light, to which it appears to act as a wholesome stimulus, while to the under surface it appears hurtful. All leaves possess irritability with respect to light, but that of many in other respects is peculiarly remarkable; the sensitive plant, (mimosa pudica), when touched by any extraneous body, folds up its leaves one after the other, while their foot stalks droop as if dying; the torpid lobes of the dionæ muscipula, or venus's fly trap, and also those of the sun dew, when touched near the base, fold themselves together and imprison any insect in their way; while the ascida or pitchers of the cephalotus folicularis, and of nepenthes, have lids that are hydrometers, opening and shutting according to the moisture or dryness of the air. Thus, when the air is dry, the ring round the lip of the pitcher of nepenthes contracts, and allows the lid to shut down, but when it is moist, the ring swells with the moisture it has attracted, and forces up the lid; and here must be remarked, a beautiful contrivance of the great Author of nature, that in order that the fluid contained in this foliaceous pitcher may not be over set when the quantity is large, a small hook at the back of the pitcher close to the hinge of the lid, is attached, which, when it is hooked upon any neighbouring part of the plant, the upright position of the pitcher is maintained.

Of the Nutrition of Plants.—The constituent *parts of earth* and water form the proper nutri-

ment of vegetables: each plant has an affini
for certain component parts of the soil, and p
sesses an internal alterative and assimilati
power, by which it disposes and combines
aliment, to form certain peculiar principles; th
we find plants of opposite virtues and flavou
grow and flourish beside each other in the sa
soil. The principal aliment that a plant dra
from the earth is water, or rather certain pa
of it, for in it a plant can live and propagate
self, without any other assistance than light a
air. Before the constituent principles of wa
were known, it was impossible to explain
even to conceive the growth of plants by t
single aliment; but when we consider water
formed of the oxygenous and hydrogenous gas
it is easily understood that this compound is
duced to its principles, and that the hydrogen
gas becomes a principle of the vegetable, wh
the oxygen is thrown off by the vital forc
From the atmosphere plants absorb nitrog
and vegetation is always more vigorous, wh
putrid vegetable or animal bodies, which affo
this gas by their decompositon, are brought i
contact with its powers. Plants imbibe, al
both from air and water *carbonic* acid.

Products of Plants are mucilage, which h
a great analogy with the mucous fluids of a
mals, and forms the basis of the proper juic
or sap of plants. The fixed and volatile o
saccharine matter, with acids and alkalies. T
feculdi of vegetables is a slight alteration
mucilage, and may be seen as size, starch,
vegetable gluten, which is the sticky part,

which freshly made readily putrifies. Farina, or flour, is composed of three principles; the amylaceous principle, or starch; the saccharine principle, or sugar, and the glutinous or animal principle. Each of these principles is capable of a different kind of fermentation; the saccharine principle undergoes the spirituous fermentation; the glutinous suffers the process of animal putrefaction, and the amylaceous is changed by the acid fermentation.

BOTANY.

(Continued.)

Beautiful flowers, that shed perfume
Upon the rosy lip of dawn;
Or, bursting forth in virgin bloom,
Glisten beneath the eye of morn!

Beautiful buds, whose tender forms
Survive the deadly lightnings' glare,
And bend your bosoms to the storms
That rise upon the midnight air!

Beautiful blossoms, where the bee
Quaffs nectar daily with a kiss,
And trembling round you in his glee
Pours out in song his note of bliss!

Say, were ye only born to fade,
Or were your tints and odours given,
To give the spirit in the shade
Of this dull world, some glimpse of heaven?

Language ye have, and syren spells,
And angel whispers day by day,
That reach the soul when it rebels
Against confinement in its clay,
That sweetly utter stay, oh stay.

Speak then again as ye have spoken,
When I have idly passed you by;
Give me again each holy token
Of love and goodness from on high!

Give me those thoughts and morals, ste
To the charm'd heart with many a si
Give me again those hopes revealing
Sensations far too proud to die!

CHAPTER V.

Parts of a Plant—Process of Fructification—Pecu
sions by the Author of Nature—Remarkable co
for their preservation—Enfolding and Growth of
—Germination—Dispersion of Seeds, and re-pro
Vegetables.

One of the most interesting parts of
is that relating to the fructification of
and in it may be observed a most beau
play of divine wisdom and goodness
must call forth from the most superfi
server, admiration and gratitude tow
Almighty Creator and Governor of all
The term fructification implies that
which brings the seed to perfection, a
prehends the flower and fruit, with all t
ratus necessary to the perfecting of t
which consists of seven parts.—1. T
cup or empalment, of which there a
kinds. 2. The *corolla* blossoms or pe
The stamens or chives, which are v

number, and situated within the corolla. These are the essential organs of impregnation. 4. The pistil or pointal, which is found within the centre of the circle, &c. formed by the stamens, but sometimes placed in a different individual blossom in the same species of plant. That furnished with stamens being called the male or barren blossom, that with pistils the female or fertile one. 5. The pericarp or seed vessel, formed by the germen enlarged. 6. The seed or fruit, found within the pericarp; and lastly, the receptacle or base, on which the whole of the apparatus of fructification is supported. We shall now consider these parts separately.

The Calx, is an extension of the outer bark or rind of the plant, diverging and forming a kind of couch for the support of the other parts; it however, appears like a cup as in the polyanthus; like a sheath as in the daffodil; like a husk as in the oat; and with many other variations.

The Corolla (properly called petals) is that beautiful coloured part of a flower we call the blossom, and is produced from the inner bark of the tree or plant, and seems designed to protect the stamens and pistil from any injury which might occur from external causes. It varies in shape, colour, and number of petals. The nectary which secretes the honey in plants, sometimes forms a part of the corolla, or is appended to it; sometimes however, the petal itself secretes honey; sometimes a set of glands perform this function, and in other cases there is a peculiar petal-like apparatus, for preparing and preserving the nectarious juice. The use of the

nectary and its contents, is supposed to answer two purposes, the nourishment of the tender seed bud, and to tempt insects to visit it, to promote the impregnation of the flower.

The Stamens or Chives are produced from the wood of the plant, and are situated within the corolla, and usually consist of the *filament* or thread, long and thin, which is attached to the bottom of the corolla, and the *anther* or button, placed at the top of the filament; the anther is a kind of box, which opens when it is ripe, and throws out a yellow dust, called pollen or farina, which is absorbed by the pistil.

The Pistil consists of three parts; the *Germen* containing the rudiments of the future seed; the *Style* placed over the germen, which is not however universal, and is sometimes entirely wanting; and the *Stigma* which is of different forms, but always placed on the top of the style, or where the style wanting on the germen; the use of the stigma is to receive the pollen, which is conveyed along the tubular body of the style, (or perhaps some subtil fecundating effluvium that issues from it) to verify the seed. And here may be noticed a beautiful display of the providence of the Almighty, for it is observed, that the length of the pistil varies according to the position of the flower. In flowers that are erect, the pistil is *shorter* than the *stamens*, that the pollen shed from the antheræ, may be caught in its descent by the head of the pistil called the stigma:—but when flowers hang *down their* heads, (as the crown imperial for *instance,)* it plainly appears, that were the pistil

in *this* case, *shorter* than the stamens, the fecundating dust would fall to the ground, without a possibility of its being absorbed by it; but here we find the Divine Author of Nature has removed the difficulty, by ordaining that the pistil in flowers of this kind should be *longer* instead of *shorter* than the stamens; that the protruding summit (the stigma) may receive the pollen, from the antheræ as it falls by its natural gravity towards the earth.

The Stamen and Pistil are usually situated on the same flower, in double flowers they are changed into petals; sometimes they are on the same individual plant, but placed upon different flowers, and at other times they are upon separate plants. Here then is a difficulty which nothing but the most consummate wisdom could have removed; the Almighty could doubtless have ordained all plants to have stamen and pistil on the same flower; but in proceeding in the way we are about to describe, we find that two purposes are accomplished, and the service is reciprocal. It is necessary that the pollen from the anthers should be brought into actual contact with the surface of the stigma; small insects and bees, &c. are the agents appointed for this purpose. The bee or fly is allured from one flower to another in search of honey (his proper food) and in his daily travels, brushes the pollen with his wings, legs, and body, from one flower, and on visiting another, must leave some portion of it behind him. The flowers which have only *anthers, do not* in general afford honey, as this *nectar is* generally contained in the base of the

pistil; and it is here the busy insect seeks
plunges in his proboscis, and extracts the d
cious fluid. If he do not drop any of the pol
adhering to his body, he may at another t
renew his repast: but if any of it fall, it is
mediately absorbed, the act of conceptio
accomplished, or the seed is impregnated:
the organs which afford the nectar dry up
wither from that moment, while the seed ri
to maturity.*

Many instances of the peculiar provisi
which the Almighty makes for the perpetua
of the vegetable parts of creation might be
related, which want of space obliges us to
over; but the admirable process established
the fructification of water plants, is too inter
ing to remain unnoticed. The water lily
stalk still lengthening proportionate to the d
of the water, rises through, bearing its beau
blossom constantly buoyant upon the surf
until its seeds are rendered fruitful, when t
capsule sinks beneath, generally many feet be
the surface of the water. In the Vallisneri
Italy, the flowers of the *female* plant float on
surface of the water, and are furnished wit
elastic spiral stalk, which expands or contr
as the water rises or falls; the flowers of
male plant are produced *under* water, b
soon as the fecundating farina is mature,
separate themselves from the plant, rise to

* The pollen is also carried about by the a
phere; and it has been assumed, that a mutual at
tion exists between it and the pistils of plants
same species.

surface, and are wafted by the air or borne by the currents to the female flowers.

The next part of the organs of fructification, is the pericarp or seed vessel, which is the pistil enlarged by the seeds encreasing in size; it is not, however, an essential part, for many plants have naked seeds, guarded only by the permanent parts of the flower. There are several kinds of seed vessels; the *capsule*, exemplified in the poppy; the *salique*, in the wall flower; the *drupe*, in the cherry, peach, &c., the *pome*, in the apple and pear; *legume*, a shell, as in the pea; the *berry* (bacca) containing one or more seeds lodged in the pulp, as the gooseberry and strawberry; the *silicle*, seen in the honesty; the *nut*, as in the filbert, acorn, &c., and the *cone*, (strobilus) as in the fir.

The SEEDS (semina) are the most essential parts of fructification, being those to which all other parts are subservient; they are similar to the eggs of animals, and contain the future vegetable in embryo. The embryon plant or germ, called by Linnæus *corculum*, i. e. a little heart, is the principle of life in the future plant, and is contained within the lobes; it consists of two parts; the *plume*, which forms the stem; and the *beak*, which becomes the root. The parts which surround the germ on every side, are formed of paranchyma, which imbibes juices from the earth, elaborates them, reduces them to a proper nutriment, and then transmits them to the enclosed germen; until the infant plant becomes sufficiently strong to perform the work of digestion without assistance.

Seeds in general are divided into two l
some, however, have more, and others
undivided and entire, but their essential p
ties, when considered with regard to the
ples of vegetation, are all the same.

The great garden bean affords a better
tunity of tracing the infolding and growth
germ than most seeds, as its parts are re
ably conspicuous. It is outwardly covere
two coats, or membranes, which being ren
discover two lobes, called the cotyledons,*
are covered with a thin film, or cuticle
substance is not a mere concreted juice,
curiously organized, and consists of a vas
ber of small bladders, filled with paranc
or pulp. In the centre of the two lobe
joined to each, lies the embryon plant.
thick end of the bean there is a small hol
ble to the naked eye, immediately over th
cle, or future root, that it may have a fre
sage to the soil. The plume bud, or gerr
the radicle, are the different extremeties
same body. Within the radicle there is co
ed a substance called the seminal root,
divides into three branches; the middle on
directly up into the plume, the other tw
into the lobes of the seed on each side, bu
forth smaller branches through the body, ti
ramifications become quite minute on the s
of the lobes. When the seed is sown a
moisture of the earth absorbed by the outer

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* *The cotyledons in the pine tribe are four
grapes only one.*

it finds its way into the pulps, or inner part of the lobes, the minute branches of the seminal root take up the moisture and convey it into the main trunk; the sap thus supplied, runs in two opposite directions, part of it ascends into the plume, and promotes its growth and expansion, and part of it descends into the radicle, for nourishing it; when the radicle begins to take root in the earth, and to absorb some moisture, not, however, in a sufficient quantity to supply the exigencies of the plume, the two lobes rise along with the plume, assuming the appearance of two leaves, which defend the young plume from the injuries of the weather, and at the same time, by absorbing dew, air, &c., assist the tender radicle in nourishing the plume,* with which they still have a connexion by means of the seminal root above described. But when the radicle, or second root, has descended deep enough into the earth, and absorbs of itself sufficient nourishment for the plume, these seminal leaves, being of no further service, begin to decay and fall off. In this way is every plant (with some slight variations) that is raised from seed produced, affording proof of a most marvellous care and contrivance for the perpetuity of the several species.

Other remarkable contrivances by which the Author of Nature provides for the safety of

* This is not, however, the case with wheat, or any of those plants which have but one cotyledon, (called monocotyledones), as their seeds consist chiefly of the albumen, which remains in the ground nourishing the *embryo, until its* leaves and roots are sufficiently perfected.

it was evidently the intention of the Almi
that every part of the earth should be co
with plants, and for this purpose he has ad
different kinds to different climates. Some
grow on the highest parts of mountains,
bear the severest cold, whilst many other
flourish under a burning sun. If every
however, was confined to its own district
short time many kinds would perish, by no
ing room for their growth, or for the propa
of their seeds: consequently the Almight
made peculiar provision for many speci
seeds; some are furnished with what a
improperly called wings, by which they ar
ried a great distance from the plant that pro
them, and others are furnished with little
by which they stick to animals which
against them; and, lastly, some seed vesse
burst by the sun's heat, and throw out their
with a violent jerk to some distance. The
duction of vegetables, however, is not a
plished by seeds alone, for our forests ar
petuated by the roots of the large trunks,
are left in the ground in order that the
throw off suckers; after a certain time the
separated from the trunk that gave them
and planted in other situations; and some
plants, as the strawberry, furnish branches
creep along the ground, taking root at
distances, while many roots are multipli
offsets.

It is also worthy of remark, that those
that are too weak to support their own
are furnished by tendrils or claspers, by

they are able to cling to each other, and thus to sustain themselves, or to clasp those that are stronger. In these plants, from each knob or joint, or, botanically speaking, *axilla* of the plant, issue close to each other two shoots, one bearing the flower and fruit, the other drawn out into a wire, a long tapering spiral tendril, that twists itself round any thing that lies in its reach: here are two shoots commencing at the same point, but of perfectly different forms, and for very different purposes; the one to *bear* the fruit and the other to sustain the *weight* of it, as it increases to perfection; how beautiful is this arrangement, and it is further interesting to notice, first, that in general these supporters do not make their appearance till wanted, and secondly, they are confined only to those plants whose stems are unable to support their products; for we behold the pea putting forth tendrils and the bean none, and why? because the stalk of the pea cannot support itself, the stalk of the bean can.

It is impossible to follow plants into their several species; were we to do so, we should still find the wisdom, benificence, and superintending providence of the Deity apparent in every plant we might examine. We cannot with our mortal eyes behold the presence of the Almighty, but he has given us the glorious privilege of seeing him in his works, of *meeting* him in every blade and every bough, where his most exquisite workmanship is revealed. After the spiritual worship he requires of us in our closets or in his *temples, there* is no way saving the active dis-

charge of christian duty to our fellows, by which we can more essentially please him, than by contemplation of the harmony and beauty of nature, and by following him through the inexhaustable wonders of his creation.

BOTANY.

(Continued.)

Eternal God!
We view Thee here in glorious majesty,
Dazzled with thy perfections and thy love;
Our spirits fail us when we strive to trace
Thy wisdom and thy goodness. Eagle thoughts
That spread their wings to meet Thee in high joy,
Soon lose themselves in the transcendant blaze
Of thy dread attributes, and in their flight
Sink down o'erpowered. Merciful Father, come
And help us when we falter, do not suffer
The excess of glory unapproachable
To dim the eye, although it strives to look
On Thee with impious inquiry,—still
Strengthen its vision; teach our souls to bear
The flood of light unharmed, and guide us to
The blessed record of thy will; and when
The thousand wonders of the olden time,
The cloud by day, the flaming fire by night,
The gushing rock, and the stern thunder peal,
In which thy laws were issued, fill our hearts
With wonder—then be with us; in the midst
Of each convulsion that would shake us, be
Near us to help our faith, and shield us when
Dark thoughts send out their poison'd missiles, and
Armed doubts beset our path. 'Tis Thou alone
Canst help us and deliver us.—Thou wilt,
For Thou dost work, Almighty Saviour, still

Dost Thou work in miracle ; still the blind
Receive their sight, the dumb are taught to sing,
The deaf to hear, and the very dead are raised
From darkness and the grave ; Thy voice still cries
" Come forth." The water of eternal life
Gushes from Thee ; and from the spirit's eye
Scales drop, and glory beams.—Thyself, the same
That stood at Nain by the widow's son,
Stands by the faithful even now. Thou still
Dost rule the storm and bid life's tempests cease,
Heard, felt, seen, known, adored, believed,
By all thine own : Thou visitest at morn,
At mid-day, in the silence of the night,
Yea, in the bustling turmoil of the world,
'Mid vanity and pride and sin and woe,
Walks in the self same mien and pitying eye
That old Judea knew.

CHAPTER VI.

Every system in natural history contains certain divisions and sub-divisions, which are denominated class, genus, species, and variety; these are of course applicable to plants, and consequently many able botanists have endeavoured to arrange plants in such a manner as that they might be easily distinguished, and referred to without confusion: plants, however, are so numerous, and those parts on which systems depend so liable to variations and irregularities, that no system as yet been invented, even fully capable of comprehending the vast number of *known* plants, while those with which we are but very imperfectly acquainted, are so numerous that they baffle human ingenuity in its attempts to class them all, according to their mutual re-

lationships or affinities; for there must ever be defects in all attempts of the human intellect to keep pace with the infinite variety displayed in the works of God.

The arrangement, therefore, of plants, has been attempted by botanists with reference to their external characters, and by the number and proportion of their more minute parts; the former of these has been called the *natural* system, the latter the *artificial* one: the first was the method adopted by Jussieu, the other was adopted by Linnæus. It might be supposed, when we behold so frequently a large number of plants, bearing a very striking resemblance to each other in forms, and ascertain that the same resemblance holds in their internal qualities, between such plants as resemble one another in configuration, that a natural system would be the most easy of comprehension; but when the science of botany is entered upon, plants are found so numerons and diverse, approaching each other so closely in some particulars, and receding so much in others, that what has been termed a natural system become almost too intricate for comprehension. Such are the difficulties that environ Jussieu's method, which with all its ingenuity must be considered imperfect.

The Linnæan system of botany, which has superseded all others, and is now almost universally adopted, is founded on the situation, number, and proportion of those parts of plants lea*liable to* variation, viz. the stamens and pisti*and divides* all vegetables in 24 CLASSES; th*classes contain* 109 ORDERS, these orders

upwards of 2000 GENERA, and these genera in about 40,000 SPECIES, 3000 of which are found in England, with almost innumerable *varieties*.

The Classes and Orders OF THE LINNEAN SYSTEM ARE AS FOLLOWS.

CLASS I. *MONANDRIA*.

One STAMEN, including *Two* ORDERS.

Monogynia, of which the Samphire (Salicornia) is a specimen; and *Digynia*, which affords the Strasburg Blite, (Blitum).

CLASS II. *DIANDRIA*.

Two STAMENS.—ORDERS *Three*.

Monogynia—The Lilac, (Syringia). *Digynia*—Sweet scented Vernal Grass, (Anthoxanthum). *Trigynia*—The Pepper, (Piper).

CLASS III. *TRIANDRIA*.

Three STAMENS.—ORDERS *Three*.

Monogynia—The Crocus. *Digynia*—Wheat, and most of the Grasses. *Trigynia*—(Holosteum).

CLASS IV. *TETRANDRIA*.

Four STAMENS of one length.—ORDERS *Three*.

Monogynia—Plantain, (Plantago). Digynia—Mustard Chickweed, (Buffonia tenuifolia). *Tetrygynia*—Holley, (Ilex).

Class V. *PENTANDRIA.*

Five Stamens.—Orders *Six.*

Monogynia—(Convolvulus). *Digynia*—Parsnip (Pastinaca). *Trigynia*—Elder, (Sambucus). *Tetragynia*—(Parnassia). *Pentagynia*—Flax, (Linum). *Polygynia*—Mousetail, (Myosurus). This is a very numerous Class, and comprises the Honeysuckle, Primrose, with Lungwort, Henbane, Nightshade, Parsley, Fennel, and the Currants, among its several Orders.

Class VI. *HEXANDRIA.*

Six Stamens, same length.—Orders *Six.*

Monogynia—Lily. *Digynia*—Rice, (Dryza). *Trigynia*—Dock, (Rumex). *Tetragynia*—(Peliveria alliacea). *Hexagynia*—(Stratiotes). *Polygynia*—Water Plantain, (Alisma). The far greater parts of this Class is composed of Liliaceous plants, among which may be enumerated the whole family of Lilies. The Tulip, the Daffodil, and Snowdrop, are also of this Class, as are also the magnificent Amarythis and the great American Aloe.

Class VII. *HEPTANDRIA.*

Seven Stamens.—Orders *Four.*

Monogynia—Horse Chesnut, (Æsculus). *Digynia*—(Limeum). *Tetragynia*—(Saururus). *Heptagynia*—(Septas). This is the smallest of all the Classes. Wintergreen and Chickweed are also examples.

Class VIII. *OCTANDRIA.*

Eight Stamens.—Orders Five.

Monogynia—Heaths, (Erica). Digynia—Ga-

lenia, (Africana). *Trigynia*— (Polygonum). *Tetragynia*—Bulbous Fumitory. In this Order are found various species of the Ash, the Willow, and the Mezereon.

Class IX. *ENNEANDRIA.*

Nine Stamens.—Orders *Three.*

Monogynia—Bay Tree, (Laurus). *Trigynia*—Rhubarb, (Rheum). *Hexagynia*—Flowering Rush. (Butomus), which is the only plant found wild in England that belongs to this Class; it, however, comprises many remarkable foreign plants, among which, Casssia, Camphor, Sassafras, Bay, and Cinnamon, are conspicuous.

Class X. *DECANDRIA.*

Ten Stamens.—Orders *Five.*

Monogynia—Rue, (Ruta). *Digynia*—Pinks, (Dianthus). *Trigynia*—(Silene), with the Sandworts and Stitch-worts. *Pentagynia*—Sorrel, (Oxalis), with the Stonecrops. *Decagynia*—(Phytolacca).

Class XI. *DODECANDRIA.*

Twelve Stamens or more, fitted to the receptacle.—Orders *Six.*

Monogynia—Willow Herb, (Lythrum). *Digynia*—Agrimony, (Agrimonia). *Trigynia*—Mignionet, (Reseda). *Tetragynia*—(Aponogeton) *Pentagynia*—(Glinus). *Decagynia*—Houseleek, (Semperrivum). In this Class the number of Stamens is not to be relied on, as in some plants there are twelve, ten, or seven.

Class XII. *ICOSANDRIA.*

Twenty Stamens or more, inserted into the calx.

ORDERS *Three.*

Monogynia—Cherry, Peach, &c. *Pentagynia*—Apple, Pear, &c. *Polygynia*—Rose, (Rosa). The Plumb and Sloe, Cherry and Bullace, are of this Class, as are the Hawthorn and Strawberry.

CLASS XIII. *POLYANDRIA.*

Many STAMENS, fitted to the receptacle.—

ORDERS *Seven.*

Monogynia—Poppy, (Papaver), or Water-lily, (Nymphæa). *Digynia*—(Peony). *Trigynia*—Larkspur, (Delphinium). *Tetragynia*—(Tetracera). *Pentagynia*—Columbine, (Aquilegia). *Hexagynia*—(Stratiotes). *Polygynia*—Hellebore, Helleborus).

CLASS XIV. *DIDYNAMIA.*

Two long and *two* short STAMENS; *One* PISTIL.

ORDERS *Two.*

Gymnospermia—Lavender. *Angiospermia*—Foxglove, (Digitalis). Ground Ivy, (Glecoma), Horehound, (Marrubium), Thyme, (Thymus), Marjoram, (Origanum), are also of this Class.

CLASS XV. *TETRADYNAMIA.*

Six STAMENS, (*four* long and *two* short); *One* PISTIL; Flowers cruciform.—ORDERS *Two.*

Siliculosa—Honesty, (Lunaria); Willow-grass, (Draba); Shepherd's Purse, (Thlaspi). *Siliquosa*—Cabbage, (Brassica); Wall-flower, (Cheiranthus); Mustard, (Sinapis); Watercress, (Sisymbrium).

CLASS XVI. MONADELPHIA.

Threads united at bottom into one stem, but

separate at top.—ORDERS *Eight.*

Triandria—(Tamarindus); Crane's-bill, (Exodium). *Heptandria*—(Pelargonium). *Octandria*—(Artonia). *Decandria*—(Geranium). *Endecandria*—(Brownea). *Dodecandria*—(Pentapetes). *Polyandria*—Mallows, (Malva).

CLASS XVII. *DIADELPHIA.*

Threads of the Stamens in two sets; Flowers Butterfly shaped.—ORDERS *Four.*

Pentandria—(Monnieria). *Hexandria*—Fumitory, (Fumaria). *Octandria*—Milkwort, (Polygala). *Decandria*—Broom, (Spartium); Wood Pea, (Orobus); the Vetch or Tare, (Vicia); Saintfoin, (Hedysarum), and Trefoil, (Trefolium) belong also to this Class.

CLASS XVIII. *POLYADELPHIA.*

Threads of the Stamens in three or more parcels. ORDERS *Three.*

Dodecandria—Orange, (Citrus). *Icosandria*—(Melaleuca). *Tutsan.*—(Hypericum).

CLASS XIX. *SYNGENESIA.*

Five STAMENS; Anthers united; into a tube *One* PISTIL.—ORDERS *Five.*

Polygamia Æqualis—Endive, (Cichorium); Dandelion, (Leontodon); Thistle, (Carduus). *Polygamia Superflua*—Tansey, (Tunacetum); Daisy, (Bellis); Chamomile, (Anthemis). *Polygamia Frustranea*—Sunflower, (Helianthus); Knapweed, (Centaurea). *Polygamia Necessaria*—Marigold, (Calendula). Polygamia Segregata—Globe Thistle, (Echinops).

Class XX. *GYNANDRIA.*

Stamens attached to a growing out of the Pist

Orders *Seven.*

Monondria—(Orchis). *Diandria*—Ladies' Sli per, (Cypripendium). *Triandria*—(Salaci *Tentrandria*—(Nepenthes) *Pentandria*—(Pe gularia). *Hexandria*—(Aristolochia). *Octa dria*—(Cytinus).

Class XXI. *MONOECIA.*

Stamens and Pistils in different blossoms in t same Plant.—Orders *Eight.*

Monandria—Bread Fruit, (Artocarpus). *Dia dria*—(Anguria). *Triandria*—Sedge, (Care *Tetrandria*—Roman Nettle, (Urtica). *Pento dria*—(Amaranthus). *Hexandria*—(Zizani *Polyandria*—Oak, (Quercus); Beech, (Fagu Hasel, (Corylus). *Monadelphia*—Fir, (Pinu

Class XXII. *DIOECIA.*

Stamens and Pistils in separate Blossoms, a also on separate Plants.—Orders *Eight*

Monandria—(Brosimum). *Diandria*—Willo (Salix). *Triandria*—(Empetrum). *Tetrandri* (Trophis); Misletoe, (Viscum). *Petandri* Hop, (Humulus). *Hexandria*—(Tamus). *lyandria*—Poplar, (Populus). *Monadelphi* Juniper, (Juniperus); Yew, (Taxus).

Class XXIII. *POLYGAMIA.*

Stamens and Pistils separate in some Flowe united in others, either on the same Plant or two or three separate ones.—Orders *Three*

Monoecia—Orach, (Atriplex). Dioecia—(H *pophaë*). *Trioecia*—Fig, (Ficus).

ss XXIV. *CRYPTOGAMIA.*
ınd Pistils not ascertained with certainty.
ORDERS *Five.*

ilices). Mosses, (Musci). Liverworts,
æ). Flags, (Algæ). Mushrooms,

ung student will be careful to under-
ıt in the eleven first classes, the *Class*
any plant may belong, is ascertained
ımber of the *stamens* only; in the next
manner of their insertion either into the
eceptacle is considered; in the succeed-
the *length* of the stamens is observed;
ree following, the union of the filaments
ımens is characteristic; in the conclud-
ney are different in each, as appears in
ıeration of the orders.

veral *Orders* are determined in the first
classes, by the number of the *pistils*
shown by adding *gynia* instead of
the Greek words signifying the num-
hus we have, 1st. Monogynia, 1 pistil.
ynia, 2 pistils. 3rd. Trygnia, 3 pistils.
ragynia, 4 pistils. 5th. Pentagynia, 5
6th. Hexagynia, 6 pistils. 7th. Hepta-
pistils. 8th. Octagynia, 8 pistils. 9th.
nia, 9 pistils. 10th. Decagynia, 10 pis-
h. Dodecagynia, 12 to 19 pistils. 12th.
ıia, many pistils. The two orders of the
ss are distinguished by their seed ves-
. Gymnospermia, have their seeds naked
four in number. 2nd. Angiospermia,
ds in a *capsula*. The two orders of the
s, are distinguished by the form of the

seed vessels. 1st. SILICULOSA, in which they appear as a roundish pod or pericarp. 2nd. SILIQUOSA, which has them as a long slender pod. In the 16th. 17th. and 18th. classes, the *orders* are distinguished by the *number* of *stamens*. The orders of the 19th. class, which comprehend those flowers that are called compound, are therefore marked by the nature of the florets; these orders are five; in the first, *Polygamia Æqualis*, we find the florets all *perfect*, each having stamens, a pistil, and one seed (example Dandelion); in the second, *Polygamia Superflæ*, all the florets of the *disc or centre of the flower* are perfect likewise, while those of the *rays* have a pistil only, but both capable of perfecting seed (example Daisy); in the third order, *Polygamia Frustranea*, the florets in the centre or disc are *perfect* and produce *seed*, whilst those of the ray are *barren* (example Bluebottle); in the fourth order, *Polygamia Necessaria*, the florets of the *disc* have only *stamens* imperfect; those of the *rays* only *pistils*, which are *fertile*, (example, Marigold); the orders of 20th. 21st. and 22nd. classes, Gynandria, Monoecia, Dioecia, are founded upon the stamens, according to their number, union, and proportion; the orders in the 23rd. class, Polygamia, are Monoecia, Dioecia, and Trioecia, as the three kind of flowers by which that class is distinguished, occur upon *one*, upon *two*, or upon *three* different plants; the 24th. class, Cryptogamia, consists of plants whose parts of fructification are very minute or *obscure*, its orders are five; 1st. Ferns. 2nd. *Mosses*. 3rd. Liverworts. 4th. Sea Weeds. 5th. *Mushrooms*, or Funguses.

BOTANY.

(Continued.)

Lord, can we turn, and not be full
  Of love and splendour shed from Thee?
The fair, the bright, the beautiful,
  Though severed still by many a sea,
Unite with one accord, to raise
For Thee a thousand signs of praise!

The lonely height, the lofty peak,
  The fertile vale, the golden shore,
Bear rainbow florets, that would speak
  Unto the heart, and cry—*Adore!*
While many a breeze of soft perfume
Seem born to waft the spirit home.

Where is the soul that would not glow
  Amid the banyan's stemy glade?
And can the knee forget to bow
  Beneath the plantain's cooling shade?
Oh no! they cannot all forget,
Though error's chain may bind them yet:

For Nature, though her glories are
  (Compared to what salvation brings)
Like a poor glow-worm to a star,
  Hath yet a potent power, that flings
A light unto the heart and eye,
In spite of gross idolatry.

And bud and blossom still are given
  Unto the earth, like stars at night,
To speak assurance still of heaven,
  In tokens fair, and pure, and bright.
Then let us deem them all divine,
And love them Lord, for they are Thine.

CHAPTER VII.

THE GEOGRAPHY OF PLANTS.

A very important and pleasing part of Botany is that which relates to the local situation of indigenous plants, as it reveals to us some very curious and striking particulars connected with the peculiarities of the climate and situation of countries, and affords subjects of pleasing speculation to the enlightened and philosophic mind.

It would swell the contents of many volumes to give the researches of the botanic travellers of later years, but as there are some facts so striking as to be easily remembered, and others too important to be passed over, we will endeavour to present an outline of what appears the most useful and interesting.

Climate fixes plants to certain parts of the earth's surface; and although local peculiarities often vary their situation to a certain degree, nevertheless each of the great divisions of the earth appears to have given birth to a set of plants distinct from those of the other parts. The plants of the East India Islands form a distinct class, those of China and Japan another, and those of New Holland a third. In the northern parts of Europe we find shrubs and plants gradually decreasing in number and diminishing in size as we draw towards the regions of perpetual snow. Beyond the Arctic Circle the number of plants is extremely limited; a dwarfish kind of heath and stunted moss are the principal products. In Lapland we meet with the dwarf birch (betula nana) and dwarf willow (salix herbacea), the former of

which is rarely two or three feet in height, and the latter only as many inches. The celebrated moss (lichen islandicus) forms the principal food of the rein-deer, and is found almost universally. Descending a little south we find, first, the yellow water lily (nymphæa lutea) and the white water lily (nymphæa alba), and the mezereum, indigenous; next the aspen (populus tremula), and in about latitude 60° the cold alder (alnus incana), which is not found south of that latitude; after these we meet with the silver fir (pinus picea), the Scotch fir (pinus sylvestris), the common birch (betula alba), the mountain ash (sorbus aucuparaia), two or three other species of willow, and towards the Uriel Mountains, the Siberian cedar (pinus cembra). As we travel along the shores of the Baltic, we find indigenous the raspberry, the wood anemone, the hepatica, the dog rose, the sycamore, the burdock, and the campanula, with the perisicifolia, the cowslip, the guelder rose, and the spiræa filipendula. Approaching Denmark we find the hawthorn, the sloe, the beech, the hazel, and the white and the black poplar. The trees here mentioned are common, more or less, to the region of forest which stretches over a great part of the Russian Empire. In Asiatic Russia we successively lose the oak, hazel, ash, lime tree, fir, &c. while the larch extends to the Arctic Ocean. The northern limit of the oak, according to Von Buch, would be expressed by a line *drawn* from the intersection of the *parallel of north* latitude 55° with longitude

50° east. In Siberia are found the cranberry, the hautboy, the strawberry, with wild tulips, anemones, two species of rhododendron, and the scarlet lychnis; to the east of Lake Baikal we have the *Asiatic* instead of the European species of globe flower. The northern limit of corn in Russia, according to Tooke, is 60 degrees. In Great Britain the oak, beech, elm, ash, hazel, maple, sycamore, the small leaved lime, and the Scotch fir, are indigenous. In those countries south of the above latitude we meet with many tracts of bog or peat moss, similar to that found in various parts of the United Kingdom, with occasionally the bilberry and the whortleberry; to the south of this district, from latitude 55° to 45°, comprehending the greater part of France, the middle of Germany, Poland, and Southern Russia, we find remarkable fertility, and corn, hemp, flax, &c. are in universal cultivation.

The line that would mark the northern limit of the vine in Europe, would not pass higher than 49° latitude; in both hemispheres the profitable culture of it ceases within about 30° of the Equator: thus the region of vineyards occupies a band of about 20° in breadth in the Old World, and not more than 10° in the New. The line of separation between the beer and wine countries would nearly coincide with this, and would pass from the south of England, through French Flanders, Hesse, Bohemia, Odessa, and the Crimea. In the north of Italy, *west of* Milan, we first notice the cultivation of *rice, and* the cultivation of the olive is bounded *on the north* by that chain of mountains ex-

tending, with little interruption, from the Bay of Biscay in the Atlantic, to the Black Sea; and a line of separation passing along the Pyrennees, the Cervennes, the Alps, and the Hæmus, would at the same time divide the countries of butter and oil.

The culture of the fig and pomegranate is limited to nearly the same line as that of the olive; the culture of the mulberry (as food for the silkworm) appears to extend rather farther north. The orange and lemon tree, although there are several gardens of them in the city of Nice, are not met with generally above the latitude of Naples. In the south of Europe the pear and the quince are found wild, and in the forests the Spanish chesnut and the cork tree flourish, while below the chain of mountains already described, the myrtle, the pomegranate, orange, and lemon grow wild, and plants of the grass tribe (Arundo donax) are found upwards of 20 feet in height. Thyme, lavender, and rosemary, the cypress, the laurustinus, the bay, the arbutus, and the Judas tree (cercis siliquastrum), are indigenous to the same district. The auricula, the deep blue gentian (gentiana acaulis), and several species of saxifrage are found at a considerable height on the mountains, while at their base the peony (pæonia officinalis), the fraxinella (dictamnus albus), the black hellebore (heleborus niger), the laburnum (cytisus laburnum), may be seen flourishing. On the southern side of the same mountains will be found, among several other plants cultivated in England

the beautiful pyramidal bell flower (campanula pyramidalis), and the althæa frutex (hybiscus syriacus). In almost every part of Turkey, the orange, lemon, citron, pear, cherry, peach, and apricot are found, and in several places the cotton and coffee tree are to be met with. In Palestine, south-west of the Euphrates, the fig, olive, cedar of Lebanon, mulberry, and pomegranate will be noticed. East of the Red Sea is found a species of cassia, the leaf of which is the senna, used as a purgative, with a species of mimosa, from which gum Arabic is procured; and also the date palm, the tamarind, the balsam tree, frankincense, myrrh, and the caper. From Persia we have the crown imperial, hyacinth, jasmine, tulip, the ranunculus and medlar, the Persian iris, and Persian fritellary. Egypt is remarkable for grain (excepting oats, which are not known), and rice, with also the beautiful lotus (nymphæa lotus), the papyrus, a species of reed, and the mignionette. Crossing the Indus to Hindostan, we find conspicuous the balsam, the bamboo, which in a few months attains to the height of 60 feet, the kidney bean, the banyan tree (ficus indica), the cucumber, and the teak tree (tectona grandis). In India and the East India Islands are found the santalum album, which yields what is called sandal wood, and the diospyros ebenum, which yields ebony, the plant which yields the turmeric (curcuma longa), and the styrax benzoe, which yields gum benzoin. In the East Indies also a large proportion of the spice-bearing trees are to be found. In Sumatra and Java we find the laurus cassia,

the inner bark of which is the cinnamon, so well known. In the island of Japan we find the laurus camphora, which yields camphor; ginger is the root of an herb (amomum zingiber), found also in the East Indies; pepper is the seed of a trailing plant (piper nigrum,) found in Malacca, as is also the nutmeg and mace, both from a tree called myristica officinalis, and cloves from the caryophyllus aromaticus. Millet and rice, and the jatropha manihot, from which is made cassava bread and from which tapioca is prepared, are found in the tropical regions; but the two principal articles of vegetable consumption in the East India and South Sea Islands, are the fruit of what is called the bread fruit tree, and the yam, a root something like a potato, but black outside, and often of the weight of from 25 to 30 pounds.

The vegetable productions of the vast continent of America possess a much greater splendour, and are in more variety, than those of the Eastern Hemisphere. In North America, to the north of Lake Winnipeg, we again meet with dwarf birch, larch, poplar, pine, and willow. To the south of Hudson's Bay, we meet with the Weymouth pine, and the occidental arbor vitæ. Indigenous to the United States is the sugar maple, red cedar, oak sassafras, red maple, chesnut, and walnut. From the United States we have received some of the most beautiful family of the bog plants, magnolias, rhododendrons, azaleas, and kalmins. The tulip tree (liriodendron tulipifera), the arbutus (arbutus laurifolia), and one or two species of arbor vit (thuja occidentalis), with the American a

(agave Americana), and the beautiful acacia, commonly cultivated in our shrubberies. In the southern part of the United States, rice, the cotton tree, the sugar cane, the coffee tree, the tobacco plant, indigo, and the orange tree, are in cultivation. Descending south, in Mexico we meet with the sun flower, the dahlia, the tiger flower, the pine apple, the mahogany tree (sweitenia mahogani), logwood (hæmatoxylum campechianum), and fustic (morus tinctoria), are indigenous. From Peru we have the scarlet fuchsia, the nasturtium, and the potato. From Brazil we have the Jerusalem artichoke (helianthus tuberosus), the common passion flower, and here are also found the mango, the tamarind, the vanilla, the pine apple, and the hevea plant, from which India rubber is produced; while cotton maize, the olive, the vine, cacao, and indigo are in cultivation. The Islands of the West Indies produce quassia, the capsicum, cocoa nut, annatto, the mangrove, lignum vitæ, allspice (myrtus pimenta), and the tamarind. Over the whole of South America plants of the cactus family are found in abundance. The most striking plants of the Torrid Zone are the ferns and palms, the former of which attain to the height of 40 feet, and the latter (of which there are 130 species) to upwards of 160 feet. In the Torrid Zone the mallows attain an enormous magnitude, and various species of grapes, some of which have stalks considerably above *the height of* a man.

End of Third Part.

PART IV.

ZOOLOGY.

Another step towards Thy Majesty,
Thou Essence unapproachable, that we
Call God, Jehovah, Deity, and Lord.
Hark! for a pulse is beating welcome now,
Now, as the soul mounts in the scale of being,
Life, vital heat, the crimson current rushing
Through varied forms of grace and beauty, break
Upon the mental vision—they are thine,
First Cause and End of all things, Deity;
And bear the bright impressions of thy love,
From the brisk fire fly, that would vie at night
With the wild meteor in his frantic course,
Even to that glorious bird whose plume dissolves
In light upon the sapphire sky. What joy!
What extacy! Eternal Lord of all!
Thus step by step to mount towards Thee, and
In the sublime career communion hold
With Thee, and all Thy attributes of good;
And, as we pause, to find pure gratitude,
Carved deeply with the finger of Thy power
Upon the stony tablet of the heart!

To man alone, that heaven-born joy is given,—
To man alone the limit of that chain,
Which from an atom even unto Thee
Is all connection, strength, and harmony;
For where mean matter ends spirit begins,—
To fill *the* wide hiatus, that would else
Exist 'twixt dust and Deity. 'Tis mind—

The glorious, deathless mind; that germ of hope,
That pledge of immortality, that is
The link of sacred union between
Immortal man and an Eternal God.
Oh! Thou undefinable Essence, shrined
In a mysterious glory of proud things,
And with unutterable imaginings
Sparkling about Thee, like the fiery rays
Of some bright weapon, whirled in triumph, that
Conceal its beauty by their flashing gleams.
The universe hath limits still—but THOU
And thy creations, they are infinite,
And make themselves an eternity,
Even in the germ of being—wrapt in these,
As in a panoply of living light,
We brave the fierce and terrible array
Of the ten thousand foes that hedge the path,
The darkened, dubious path of mazy life,
And calmly walk into thy palace, Death,
Yea, dare thee on the footsteps of thy throne.

CHAPTER I.

THE LINNEAN SYSTEM.

Zoology comprises the history, description, and systematic arrangement of Animals, generally distinguished by the name of Quadrupeds, Birds, Amphibia, Fishes, Insects, Testaceous Animals, and Zoöphytes.

The Linnean System distributes animals 1st. into Animals that have warm and red blood, and a heart divided into two ventricles; consisting of Quadrupeds and Birds, the former being termed viviparous, i. e. brought forth perfectly *formed,* and the latter oviparous, i. e. produced *from eggs.*

The second division includes those animals with a heart containing a single ventricle, with the blood, though red, below the common temperature, such as frogs, lizards, serpents, and more particularly fishes.

The third division of animals consists of such as have a heart with a single cavity, and a cold, whitish, and nearly colourless blood; this comprises insects and worms.

The more general arrangement of Linnæus divides all animals into SIX CLASSES, which are as follows:

1, MAMMALIA; 2, AVES; 3, AMPHIBIA; 4, PISCES; 5, INSECTA; 6, VERMES.

CLASS I. MAMMALIA,

Is divided into SEVEN ORDERS, which comprehend all such animals as suckle their offspring.

Order 1. PRIMATES. Its characters are, four front or cutting teeth above and below, and one canine or dog tooth on each side of these. To this order belongs Man, and the chiefs of the creation. The genera are, 1, *Simiæ*, including ourang outang, apes, monkeys, baboons; 2, *Lemur*, macauco; 3, *Vespertilio*, bat.

Order 2. The second order of the first class is called BRUTA, and is characterized by the absence of the front or cutting teeth in the upper and lower jaw, feet armed with hoof-like nails or claws, and the pace generally slow. The chief genera are, 1, *Bradyphus*, sloth; 2, *Dasypus*, armadillo; 3, *Manis*, pangolin; 4, *Myrmecophaga*, anteuler; 5, *Platypus*, ornithorynchus or duck-bill.

Order 3. The third order of Mammalia is denominated FERÆ, and contains the predaceous quadrupeds, all agreeing in having teeth evidently calculated for feeding upon flesh, which are in general six front teeth in either jaw, and a single tusk or canine on each side, on both jaws. The genera or tribes of this order are, 1, *Canis*, including the dog, wolf, hyæna, fox, and jackall; 2, *Felis*, cat, lion, tiger, leopard, lynx, panther, &c.; 3, *Viverra*, weasel, ferret, polecat, civet; 4, *Ursus*, bear; 5, *Didelphis*, oppossum; 6, *Macropus*, kangaroo; 7, *Talpa*, mole; 8, *Sarex*, shrew; 9, *Erinaceus*, hedgehog.

Order 4. The fourth order is called GLIRES, or sleepers, from the Latin word *glis*, signifying an animal of the dormouse tribe. The animals of this tribe are characterized by two long front teeth in each jaw, standing close together, but at a distance from the grinders, with no canine teeth or tusks: the genera are, 1, *Hystrix*, porcupine; 2, *Castor*, beaver; 3, *Mus*, mouse and rat; 4, *Cavia*, Guinea pig; 5, *Arctomys*, marmot; 6, *Lepus*, hare; 7, *Sciurus*, squirrel; 8, *Myoxus*, dormouse; 9, *Dipus*, jerboa; 10, *Hyrax*, Cape and Syrian rabbit.

Order 5. The fifth order, named PECORA, contains all the various kinds of cattle, including the deer, antelope, camel, musk, &c. among its genera: the whole order without exception feed on vegetable food: it is characterized by six or eight front teeth in the lower jaw, situated at a considerable distance from the grinders; no front teeth in the upper jaw; feet with hoofs. The genera are, 1, *Elephas*, elephant; 2, Camelus,

camel, lama, dromedary; 3, *Giraffa*, giraffe or camelopard; 4, *Cervus*, elk, deer, &c.; 5, *Bos*, ox, buffalo; 6, *Moschus*, musk; 7, *Antilope*, antelope, chamois; 8, *Ovis*, sheep; 9, *Capra*, goat. The animals of this tribe have four stomachs, and possess the power of rumination, that is, of throwing up into their mouth at intervals a portion of food, which has been hastily swallowed during feeding, in order that it may undergo a more complete grinding by the teeth. The animals of this order are hoofed, the hoofs divided in the middle; and excepting the camel, they have two false hoofs, which, in walking, do not touch the ground. Such as have horns have no tusks, and such as have tusks have no horns.

Order 6. The sixth order is denominated BELLUÆ, including only four genera, viz. 1, *Equus*, the horse, ass, zebra; 2, *Rhinoceros*; 3, *Hippopotamus*; 4, *Tapir*; 5, *Sus*, those of the hog kind. The animals of this order have obtuse wedge-like front teeth in both jaws, and feet with hoofs.

Order 7. The seventh order of the class Mammalia is called CETE, or CETACEA, of which the animals have pectoral fins instead of feet, and comprises the cetaceous mammalia, or whale tribe. They have lungs, and breathe; warm blood, and a heart resembling in conformation that of quadrupeds, and they produce and nourish their young in the same manner; the genera are, 1, *Balæna*, proper whales; 2, *Physeter*, spermaceti whales; 3, Delphinus, dolphin, porpoise, &c.; 4, *Monodon*, narwhal, sea unicorn.

CLASS II. AVES.

The second class of animals in the Linnean System is denominated Aves, or Birds, who, like the Mammalia, have warm blood, a heart with two ventricles and two auricles, and lungs for the purpose of respiration; they are distinguished from them by their feet, feathers, bill, &c.

Birds are divided by Linnæus into SIX ORDERS: 1, ACCIPITRES; 2, PICÆ; 3, PASSERES; 4, GALLINÆ; 5, GRALLÆ; 6, ANSERES.

Order 1. ACCIPITRES, or predaceous birds; feed entirely on animal food: their beaks are hooked, strong, and notched at the point; their necks, wings, and whole body, strong and muscular; their claws are sharp pointed, and their sight piercing: the genera are, 1, *Vultur*, vulture, condor, &c.; 2, *Falco*, eagle, falcon, kite, hawk; 3, *Strix*, owl; 4, *Lanius*, shrike or butcher bird.

Order 2. PICÆ, or Pies. In these the bill is somewhat compressed at the sides, and convex on the top; their food is principally of a vegetable nature, or insects: the genera are, 1, *Buceros*, rhinoceros bird; 2, *Ramphastos*, toucan; 3, *Psittacus*, parrot kind; 4, *Picus*, woodpecker; 5, *Paradisea*, birds of paradise; 6, *Alcedo*, king fisher; 7, *Cuculus*, cuckoo; 8, *Trochilus*, humming bird; 9, *Corvus*, crow, raven, jay, &c.; 10, *Coracias*, roller.

Order 3. PASSERES. The birds of this *order have* their bill formed so as to act in the *manner of* forceps; their food is either animal

or vegetable; they excel in the formation of their nests: the genera are, 1, *Columba*, pigeons; 2, *Turdus*, thrush, blackbird; 3, *Ampelis*, chatterer; 4, *Loxia*, gross beak; 5, *Emberiza*, bunting; 6, *Motacilla*, nightingale, redbreast, wren, &c.; 7, *Hirundo*, swallow, martin; 8, *Caprimulgus*, goat sucker; 9, *Alauda*, lark; 10, *Sturnus*, starling; 11, *Fringilla*, sparrow, linnet, canary bird, finch, &c.

Order 4. The fourth order is termed GALLINÆ, and includes those birds that are more or less allied to the common domestic fowl, and are characterized by short wings, heavy bodies, short and strong bills, very convex, and broad claws connected at the base to the first joint: the genera are, 1, *Tetrao*, grouse, quail, partridge; 2, *Numida*, Guinea fowl; 3, *Meleagris*, turkey; 4, *Phasianus*, pheasant; 5, *Pavo*, peacock; 6, *Otis*, bustard; 7, *Didus*, dodo; 8, *Struthio*, ostrich; 9, *Casuarius*, cassowary or emu.

Order 6. The next order of birds is denominated GRALLÆ, or Waders, and comprises those birds that have long legs, and frequent watery situations, and whose food consists of aquatic insects or fish; some, however, feed on seeds and vegetables; their bill is generally long, and the thighs often bear feathers above the knee: the genera are, 1, *Ardea*, crane, stork, heron, bittern; 2, *Mycteria*, jabiru; 3, *Tantulus*, ibis; 4, *Numenius*, curlew; 5, *Parra*, jacuna; 6, *Psophia*, trumpeter; 7, *Platalea*, spoon bill.

Order 6. The sixth order, ANSERES, comprehends all kinds of water-fowl, and are, in their general structure, calculated for that ele-

ment; the feet in all are widely webbed; their food consists of water insects, fish, and water plants; they rest generally on the ground, or on lofty rocks, and in their flight are seen in flocks, preserving a certain order: the genera are, 1, *Colymbus*, diver; 2, *Larus*, gull; 3, *Procellaria*, petrel; 4, *Diomedia*, albatross; 5, *Pelecanus*, pelican, corvorant; 6, *Anas*, swan, duck, goose; 7, *Mergus*, goosander; 8, *Alca*, awk, puffin; 9, *Aptenodytes*, penguin.

CLASS III. AMPHIBIA.

The animals of the third class called Amphibia, have a cold, and generally a naked body; their colour is lurid, and smell nauseous; a few of them are furnished with a horrid poison. This class includes all animals who live with equal facility either on land or in water, and some others. Amphibious animals have the singular property of being able to suspend the function of respiration, and can perform it in a more arbitrary manner than other animals; and it is the peculiarity of the internal organization adapted to this purpose that forms the points of agreement in the whole class. Many of the Amphibia are endowed with a degree of reproductive power, and will be furnished with new feet, tails, &c. when those parts have been by accident destroyed.

The whole class was formerly divided by Linnæus into four orders; it is however now divided into TWO, as follow.

Order 1. REPTILA; in which are four *genera*, *1, Testudo*, tortoise, turtle; 2, Rana,

frog, toad; 3, *Draco*, dragon. or flying lizard; 4, *Lacerta*, lizards, crocodile, chameleon, newt, salamander, iguana.

Order 2. The second order is denominated SERPENTES, or Serpents, distinguished from the rest of the Amphibia by their want of feet. Serpents are remarkable for casting their skin; a few only are poisonous: the genera are, 1, *Crotalus*, rattlesnake; 2, *Boa*, immense serpents of Africa, India, &c.; 3, *Coluber*, viper; 4, *Anguis*, blind-worm; 5, *Amphisbæna*; 6, *Cæcilia*; 7, *Acrochordus*; 8, *Hydrus*; 9, *Langaya*; 10, *Siren*.

CLASS IV. PISCES.

All the animals of the class Pisces, are inhabitants of the water: they breathe by means of gills, and their instruments of motion are fins, which are considered analogous to the feet in quadrupeds; and it is from the situation, presence, or absence of these fins, that the divisions are instituted. They are divided into SIX ORDERS.

Order 1. is called APODES, or fishes without feet, they being entirely destitute of ventral or belly fins: the genera are, 1, *Muræna*, common and conger eel; 2, *Gymnotus*, electric eel; 3, *Anarrhichas*, ravenous wolf-fish, &c.; 4, *Xiphias*, European sword fish; 5, *Ammodites*, launce; 6, *Ophidium*; 7, *Stromateas*; 8, *Trichiurus*.

Order 2. is denominated JUGULARES, and comprehends those fish in which the ventral fins are under the pectoral or breast fins: the gener

are, 1, *Gradus*, haddock, burbot, whiting, cod, &c.; 2, *Uranoscopus*, star gazer; 3, *Blennius*, blenny; 4, *Callionymus*, dragonet; 5, *Trachinus*, weever.

Order 3. is the THORACICI, in which the ventral fins are under the pectoral: the genera are, 1, *Gymnetrus*, comet fish; 2, *Echeneis*, sucking fish; 3, *Coryphæna*, dorado; 4, *Zeus*, dory; 5, *Pleuronectes*, flounder, plaice, dab, halibut, sole, turbot; 6, *Chætodon*; 7, *Sparus*; 8, *Perca*, perch; 9, *Scomber*, mackarel, bonito, tunny; 10, *Mullus*, mullet; 11, *Acanthurus*, thorn tail; 12, *Holocentrus*; 13, *Sciæna*; 14, *Trigla*, gurnards.

Order 4. is named ABDOMINALES, in which the ventral fins are placed behind the pectoral: most of the genera of this order inhabit fresh water: they are, 1, *Cobitis*, loach; 2, *Silurus*; 3, *Exocoetus*, flying fish; 4, *Salmo*, salmon, trout, smelt, char, grayling; 5, *Esox*, pike; 6, *Clupea*, herring, sprat, shad; 7, *Cyprinus*, carp, tench, minnow, gold fish.

The next two orders comprehend *cartilaginous* fishes, which differ from the rest in having cartilaginous or sinewy, instead of bony skeletons, and in being destitute of ribs.

Order 1. CHONDROPTERYGII, have fishes destitute of bone altogether, and have cartilage instead; having also no gill cover: the genera are, 1, *Petromyzon*, lamprey; 2, *Gastrobranchus*; 3, *Ruia*, skate, torpedo, stingray; 4, *Squalus*, shark, saw fish; 5, *Lophius*, sea devil, frog fish; 6, *Balistes*, file fish; 7, *Chimæra*.

Order 2. is BRANCHIOSTEGI, *or having a gill cover; the* genera are, 1, Accipenser, sturgeon, *beluga*; 2, *Ostracion*, trunk fish; 3, Tetrodon;

4, *Diodon*, porcupine fish; 5, *Cyclopterus*, lump sucker; 6, *Centriscus*; 7, *Syngnathus*, pipe fish; 8, *Pegasus*.

These conclude the several Orders of fishes. The generic character is taken from the shape of the body, covering, structure, figure and parts of the head, &c.; the specific character is taken from the cirri, jaws, fins, spines, lateral line, digitated appendages, tail and colour.

CLASS V. INSECTA.

The name of this class is derived from a separation in the middle of the bodies of what we term insects, by which they seem cut into two parts. Insects have generally six or more legs, and breathe through pores arranged along the sides of their bodies; their skin is of a hard or bony substance; they are furnished with a moveable kind of horns, called antennæ.

Insects in general undergo various changes: from the egg is hatched the larva, called also grub or caterpillar; this afterwards changes to a pupa or chrysalis, and finally to a perfect insect. They are divided into SEVEN ORDERS.

Order 1. is named COLEOPTERA, or insects with wings, defended by a crustaceous case called elytra. This order includes almost all kinds of beetles: the genera are, 1, *Scarabæus*, beetles; 2, *Lucanus*, stag beetle; 3, *Dermestes*; 4, *Coccinella*, lady bird; 5, *Curculio*, weevil; 6, *Lampyris*, glow-worm; 7, *Meloe*, Spanish fly; 8, *Staphylinus*; 9, *Forficula*, earwig.

Order 2. HEMIPTERA, or insects with the *upper wings*, are semi-crustaceous, and tough or

leathery at the upper part; the under wings are very large, and folded up or plaited: the genera are, 1, *Blatta*, cock roach; 2, *Gryllus*, locust, grasshopper; 3, *Fulgora*, lantern fly; 4, *Cimex*, bug, &c.

Order 3. is called LEPIDOPTERA, with four wings; covered with scales: the genera are, 1, *Papilio*, butterfly; 2, 3, *Sphinx* and *Phalæna*, moths.

Order 4. The fourth order, NEUROPTERA, includes insects with naked, membraneous, or nerved wings, generally four in number, and are distinguished from the next class by being without stings: the genera are, 1, *Libellula*, dragon fly; 2, *Ephemera*, May fly or trout fly, &c.

Order 5. is termed HYMENOPTERA, or insects having four wings, but not fibrous like those of the former order, and having the tail armed with a sting: the genera are, 1, *Vespa*, wasp, hornet; 2, *Apis*, bee; 3, *Formica*, ant; 4, *Termes*, white ant; 5, *Ichneumon*, &c.

Order 6. denominated DIPTERA, consists of insects with two wings only, and comprehends the whole race of flies, gnats, &c. The genera are, 1, *Œstrus*, gad fly; 2, *Musca*, common flies; 3, *Culex*, gnat, mosquito; 4, *Hippobosca*, horse leech, &c.

Order 7. is termed APTERA, or insects without wings: the genera are, 1, *Podura*, spring-tail; 2, *Pediculus*, louse; 3, *Pulex*, flea, chigger; 4, *Acarus*, tick, mite; 5, *Aranea*, spiders; 6, *Scorpio*, scorpion; 7, *Cancer*, crab, lobster, crawfish, shrimp; 8, *Monoculus*, water flea; 9, *Oniscus*, wood louse; 10, *Scolopendra*, centipede.

CLASS VI. VERMES.

s class comprehends not only worms, which ne signifies, but also a vast variety of other ls, as snails, slugs, shells and their inha- s, with animalcula of every description. class is divided by Linnæus into 1, Mol- ; 2, VERMES; 3, ZOÖPHYTA; and 4, ALCULA INFUSORIA.

MOLLUSCA are divided into MOLLUSCA , without a shell or outward covering, asterias (star-fish) &c.; and MOLLUSCA CEA, soft bodied animals, furnished with

principal genera of MOLLUSCA NUDA , *Limax*, slug; 2, *Aplysia*, sea worm; *ris*, sea snail; 4, *Neries*; 5, *Terebella*; *rosoma*; 7, *Nais*; 8, *Sepia*, cuttle fish; *'amary Loligo*, ink fish; 10, *Medusa*, sea r, sea nettles; 11, *Holothuria*; 12, *Actinia*, emone; 13, *Asterias*, star fish; 14, *Echinus*, chin.

MOLLUSCA TESTACEA are called uni- when the shell consists of one piece, he snail; bivalve when consisting of two , as the muscle; or multivalve when con- of many pieces. The principal genera of ivalves are, 1, *Argonauta*; 2, *Nautilus*, nautilus; 3, *Helix*, snail; 4, *Dentalium*, fish; 5, *Serpula*; 6, *Teredo*, ship worm; *bella*; 8, *Petella*, limpel: those of the es are, 1, *Anomia*; 2, *Pinna*; 3, *Mytilus*, , mother of pearl shell; 5, *Spondylus*; *ma*, clamp shell; 7, Solen, razor shell; *rea*, oyster; 9, Cardium, cockle: those

of the multivalves, 1, *Pholas;* 2, *Chiton;* 3, *Lepas*, bernacle shell.

Order 2. These have two divisions, the first contains INTESTINI, inhabiting the internal parts of animals; the second is called EXTERNI, or worms found on external situations or in the earth.

The genera of the first division, comprising intestinal worms, inhabiting the bodies of animals, are 1, *Gordius*, Guinea worm: 2, *Ascaris*, thread worm, round worm; 3, *Tricocephalus;* 4, *Fasciola*, fluke; 5, *Tænia*, tape worm; 6, *Hydatis*, hydatid.

The genera of the second division are, 1, *Aphrodite*, sea mouse; 2, *Sipunculus;* 3, *Hirudo*, leech; 4, *Planarsa;* 5, *Lumbricus*, earth worm; 6, *Furica.*

Order 3. ZOÖPHYTA.* Zoöphyta, or plant animals, hold a middle station between plants and animals. The hydrapolipe first deserves notice, which may be multiplied by dissection, and every section will become a perfect animal. The hard or horny zoöphytes are known by the name of corals, and are separated into two divisions, the first containing zoöphites with a hard calcareous stem, termed corals, of which, among others, the madrepores and millepores are examples; the second division comprises those with a softer stem, and are called coralines or sea mosses, and are, actually, so many ramified sea polypes, covered with a horny case to

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*See the introduction to Natural History, page 227.

defend them from the injuries to which they would otherwise be liable.

The principal genera of the Corals are, 1, *Gorgonia*, Venus' fan; 2, *Isis;* 3, *Madrepora*; 4, *Millepora;* 5, *Tubepora.* The genera of the Coralines are, 1, *Sertularia;* 2, *Tubularia;* 3, *Flustra.*

Order 4. ANIMALCULA INFUSORIA. A countless swarm of animalcules will, by the aid of a microscope, be always discovered in almost any vegetable infusion. To the ancients the mite was the utmost bound of animal minuteness; but modern philosophy, by the aid of the most powerful instruments, has discovered whole tribes of animals, compared with which mites might almost be considered elephants. The principal genera are, 1, *Vorticella*; the *v. Convalloria* is a beautiful transparent animalcule, formed like a bell shaped flower, and furnished with a long tail or stem, by which it generally affixes itself to the stems and under surface of the common *Lemna minor*, or duck weed: the *v. Racemosa* is still more elegant; it is found in clear stagnant waters during the summer months, attached to the stalks of the smaller water plants: the *v. Rotatoria*, or wheel animal, so named from the apparent rapid motion of the head, is remarkable for its strange power of restoration to life and motion, after being dried many months in a glass. 2, *Cercaria;* the *c. Mutabilis*, or changeable cercaria, is the cause of that fine deep green scum, Shakespeare calls the "mantle of the standing pool." 3, Trochoda; *the t. Sol* is a globe or ball set on all sides

with very long diverging rays, and may be pulled or torn to pieces, and in the space of a single hour each piece will be apparently complete, and perfectly globular like the original. 4, *Volvox;* the *v. Globator* appears during spring and in autumn in the clearest kinds of stagnant waters, and has also a rotatory motion. 5, the *Vibro,* which is the largest of all the animalcular tribe: one species of this, *v. Anguillula,* or eel vibro, inhabits acid paste, and when full grown measures the tenth of an inch in length; it is viviparous, and frequently produces a tribe of young. 6 and 7, *Ciclidium* and *Monas,* are exceedingly small; a species called the *m. Termo,* when surveyed by the utmost powers of the microscope, still appears but as a kind of moving point, having merely a sensible diameter.

INSECTS.

Oh God! Thy works are infinite—all space
Is full of Thee,—the earth—the skies—the waters—
The circumambient air—all teem with life
And never ending germ. The golden pomp
Of the morn's pageantry, when sun-beams weave
The brow of Spring a coronal of flowers,
Sends forth, irradiant as the particles
Of light from light's own focus, glorious things
To magnify thy power; and chastest eve,
That with a nunlike holiness doth come
To lead the stricken heart to sanctuary,
Brings with her myriad myriad multitudes
Of sparkly atoms, organized and pure,

To teach it praise! Where shall the spirit pierce
And not find tokens still of God? The grave,
Though e'er so cold, and dark, and desolate,
She cannot shut Him out, for He is there,
Resolving, rearranging, reproducing ever
The essences of things, and bringing life
Up out of death! Ye solitudes, where awe
Profound and terrible, can rouse the soul
Into exalted action and high thought
Beyond itself! Ye fastnesses sublime,
The thrones of eagles, and the fortresses
Of lions! and ye deep entangled woods,
And wild savannahs, and all boundless plains
Where roll uncurbed the giant floods, that hear
No sound save their own dashings, or the voice
Of the majestic thunder cloud on high,
Shouting among the stars; not e'en your vast
And all stupendous features can proclaim
The LORD ALMIGHTY, more than the dark grave
Where breed the loathful maggot and the worm.

CHAPTER II.

GENERAL OBSERVATIONS ON INSECTS.

Insect Anatomy—Muscles of Caterpillars—Relative Strength of Insects—their number and variety—Breathing Apparatus, peculiar Provisions—Anatomy of the Honey Bee—Metamorphoses of Insects—Number of Eggs—The organization of the Foot of a Fly—of the Abdomen of a Silk-worm and Spider—the Wing of the Beetle—The Œstrum or Gad Fly.

In examining the various classes of the animal kingdom, with reference to the mechanical contrivances displayed in their outward peculiarity of forms and internal organization, and the provisions made by the Creator for the supply of their various necessities, we shall find throughout a most marvellous congruity, fitness, and *adaptation* of every animal to the element in

which it is destined to move, and a superintending Providence, regulating the mode in which it preserves its existence and perpetuates its species.

INSECTS, which are the subject of the present chapter, although usually looked upon by us as inferior parts of the creation, seem to afford, if possible, greater evidence of the wise arrangements of the Creator than the larger animals. In looking down upon the caterpillar that crawls upon the path, or the fly that buzzes round us, we are little aware of the wonderful mechanism and beauty of design displayed in their ephemeral and delicate forms. In the human body the muscles scarcely exceed 529, but in a large caterpillar more than 4,000 have been discovered. Lyonnet counted in the caterpillar of the goat moth 4,061—in the head 228, in the body 1,647, and around the intestines 2,186, which, after deducting 20 common to the head and gullet, gives a total of 4,061. The power also of the muscles of insects is comparatively much greater than those of larger animals: a flea is capable of springing at least 200 times its own height, which is equivalent to an elephant leaping over Mont Blanc; and by the same sort of calculation, a cockchafer is six times as strong as a horse; and if a rhinoceros were as strong as a stag beetle, it would be able to tear up rocks and level mountains.

The number and variety of insects also exceeds that of other organized bodies. There are *said to be 6,000* species of flies, and 760 butterflies, *each* different from the rest; and it i

supposed that the number of the different species of insects cannot be short of 10,000, and in this vast variety of animal forms, we are continually led to take notice of the studiously diversified methods by which one and the same purpose is attained under different situations. In the article of breathing, for example, which was to be provided for one way or other, beside the ordinary apparatus of lungs, gills, and breathing holes, (for insects in general respire not by the mouth, but by holes in their sides, as will be found exemplified in another part of this chapter,) the nymphæ of gnats have an apparatus to raise their backs to the surface of the water, and so to take in breath; the hydrocanthari do the like by thrusting their *tails* out of the water. The maggot of the evaca labra has a long tail, one part sheathed within another (but which it can draw out at pleasure), with a starry tuft at the end, by which tuft, when expanded upon the surface, the insect both supports itself in the water, and draws in the air which is necessary. Another provision in the apparatus for respiration was remarked by Réaumur in the pupa of a small crane fly; this consisted in a single tube, two or three times larger than the body of the pupa, and as fine as a hair; the point of the hair always remains above or at the surface of the water, for the purpose of carrying on respiration till the fly is ready to immerge from confinement. The common grub too, with a most curious contrivance, forms a raft or life boat for her eggs, which the most violent agitation of the water never sinks. Another most

surprising provision is also remarkable in the breathing tubes of the cheese maggot, which are not placed, as in caterpillars, along the sides of the body, but a pair near the head and another near the tail: now, when burrowing in the moist cheese, these would be apt to be obstructed, but to prevent this, the maggot has the power of bringing over the front pair a fold of skin, breathing in the mean time through the under pair, indicating another of the surprising miracles of God's power in this abject creature.

The common process of respiration of insects, although not so remarkable as those already detailed, is highly curious and interesting. In caterpillars and in most perfect insects the air is respired in breathing tubes, usually eighteen in number, placed along the sides, the mouths of which may be seen moving as the air passes in and out, from ten to thirty times in a minute. These tubes all run into what may be for analogy's sake termed windpipes, one of which lies along each side of the insect; and these two windpipes send off innumerable small branches with air to the vessels containing the digested food, supplying it with oxygen for the purpose of nourishment: a fluid is thus prepared analogous to the blood of the larger animals, and stored up in a large dorsal vessel; but this is not at all like a heart, for though it has been observed to beat, its motions do not seem to be constant or regular, and no blood vessels go off from it. The fluid analogous to blood may *perhaps* pass through this singular reservoir as *water does* through blotting paper, but as yet *this process* has not been accurately investigated.

The anatomy of the honey bee is also worthy of attention: this little insect is divided into three parts, consisting of the head, the breast, and the belly, which are united by two ligaments; the eyes are black, and of an oblong form, guarded by a horny pellicle or covering; the horns, mostly called antennæ, are placed between the eyes, near the middle of the head, and assist the insect in feeling its way, when the eyes are useless for want of light; the jaws open sideways, and being armed with teeth, serve to remove every thing that is found in the hive. In their wars with each other they use their teeth, and the wounds they inflict with them are said to be fatal. Their long trunk or proboscis is of very curious construction; it enables them to penetrate the inside of flowers, and extract their delicious juice; it is long and taper, and so pliant and flexible, that it can be contracted and folded up at pleasure: four strong scales are contrived to preserve this valuable member from injury, two of which form a sheath to it, while the whole is enclosed in a larger pair. From the breast, which is of a dusky colour and oblong form, proceed two wings and three legs on each side; the belly is divided into six lays or folds, which, by sliding one over the other, serve to shorten or lengthen the body; beside the intestines this contains a bag, which is used as a receptacle for the honey they collect; the juices of flowers are conveyed into this bag through the proboscis by a narrow pipe, which passes the head and breast. Within the thigh of the working bee is a hollow place,

edged with hair, where the bee loads the materials for wax in little pellets about the size of a peppercorn; each foot terminates in two hooks with the points opposite to each other; between these claws is a little thin substance, similar to that in the foot of the fly, as described in another part of this chapter, which enables it to walk upon smooth or polished surfaces: the sting is situated at the extremity of the belly, and is composed of two bearded darts, enclosed in a hairy sheath, which has an opening near the end for the passage of the darts; at the root of the sting is placed a small bag, filled with a venomous liquor, which is emitted through the sheaths into the wound made by the darts. In the sting of the wasp eight beards like those of fish-hooks have been discovered, one of which is longer than the other and first pierces the flesh, and then the injection of the poisonous juice finishes the process.

The metamorphoses of insects from grubs into moths and flies is also most astonishing. A hairy caterpillar is transformed into a butterfly: observe the change,—we have four beautiful wings, where there were none before; a tubular proboscis, in the place of a mouth with jaws and teeth; six long legs, instead of fourteen feet. In another case we see a smooth white soft worm, turned into a black hard crustaceous beetle, with gauze wings; and how is this accomplished? the organization of three perfectly *distinct* animals, set one within the other, yet *partaking of* a vascular system which supplies *nutrition*, growth, and life to all of them together!

yes of insects are also no less likely to
and confound us: there are no less than
hemispheres or *eyes* distinguishable in
ters of the drone fly, and each of these
r hemispheres is a perfect eye, being
d with a *cornea*, with a transparent hu-
nd with a *uvea* or *retina*; the figure of
also spherical, exactly polished, and
ely and plump. But the most remark-
ll insects for its fine pearled eyes is the
r dragon fly. Mr. Leeuwenhock reckons
lenses in each eye of this creature, or
n both, placed in a hexangular position,
ns having six others around it: he
l likewise in the centre of each lens a
ransparent spot, brighter than the rest,
ly the pupil, through which the rays of
transmitted upon the retina. This spot
ee circles surrounding it, and seemed
nes less than the diameter of the whole
also numbered 6256 pearls or hemi-
in a silk-worm's two eyes when in the
, 3181 in each eye of the beetle, and
the two eyes of a common fly.
pparatus in the feet of a fly, by which it
ed to walk on smooth surfaces or back
rds, is also most curious and wonderful;
aratus consists of two or three mem-
s suckers, connected with the last joint
ot by a narrow neck of a funnel shape
tely under the base of each claw, and
e in all directions; these suckers are
bove and hollow below the edges, being
l with minute serratures, and the hollow

portion covered with down. In order to produce the vacuum and the pressure these membranes are separated and expanded, and when the fly is about to lift his foot, it brings them together and folds them up as it were between the two claws.

The organization of the abdomen of the silkworm or spider, whereby these insects form their thread, is also as incontestibly mechanical as a wire drawer's mill. In the body of the silkworm are two bags that wind round the intestine; when drawn out they are ten inches in length, although the animal itself be only two; within these bags is collected a glue, and communicating with them are two paps or outlets, perforated like a grater by a number of small holes; the gum or glue being passed through these minute apertures forms hair of almost imperceptible fineness, and these hairs, when joined, compose the silk which we wind from the cone, and in which the silkworm has wrapped herself up. In the spider the web is formed from this thread. In the animal process of drawing the glue into a thread the substance is sometimes changed as well as the form, for within the insect it is a soft clammy gum or glue, but being of such exact chemical properties as to make it susceptible in a particular way of the atmospheric air at the moment of its exposure, a thread or web or cone so fine and so beautiful is the result.

Another nice arrangement with regard to the *mutual relationship* between various parts of *creation is* peculiar to bees. When honey is

ken from the comb it speedily ferments; now is is effectually prevented by the chemical tion of the wax of which the comb is made on the honey contained in it, and by its regular sposal into hexagonal cells, the geometrical gure of which is a thing worthy our greatest lmiration. The *elytra* or scaly wing of the nus of scarabæus or beetle is also another ntrivance; the true wing of this animal is a ght transparent membrane, finer than the finest uze, and not unlike it; it is also, when ex- nded, in proportion to the size of the animal ry large. In order to protect this delicate ructure, and also perhaps to preserve it in a e state of suppleness and humidity, a strong rd case is given to it in the shape of the horny ng called the elytron; when the animal is at st the gauze wings lie folded up under this penetrable shield; when the beetle prepares r flying, he raises the integument, and spreads t this thin membrane to the air; and it cannot observed without admiration what a tissue cordage of muscular tendons must run in rious complicated and determined directions ong this fine surface, in order to enable the imal either to gather it up into its precise m whenever it desires to place its wings under e shelter that nature has given to them, or expand again their folds when wanted for tion.

Another contrivance equally mechanical and ar, is the awl or borer fixed in the tails of rious species of flies, and with which they *rce plants,* wood, and even lime, mortar, and

stone, for the purpose of depositing their eggs in the hole thus perforated. The piercer or borer is a sharp pointed instrument, which, in its inactive state, lies concealed in the extremity of the abdomen, and which the animal draws out at pleasure; in a sheath which divides and opens whenever the organ is used, there is enclosed a compact, solid, and dentated stem, along which runs a gutter or groove, by which groove, after the penetration is effected, the egg, assisted in some cases by a peristaltic motion, passes to its destined lodgement. In the œstrum or gadfly the wimble draws out like the pieces of a telescope, the last piece of which is armed with three hooks, and is able to bore through the hide of an ox.

The shells of snails are also as wonderful and as mechanical. Other animals have their retreats or winter quarters to which they retire, but the snail carries these about with him; he travels with his tent, and this tent, though necessarily both light and thin, is completely impervious either to moisture or air. The young snail comes out of the egg with the shell upon its back, and the gradual enlargement which the shell receives is derived from the slime excreted from the animal's skin. The sealing up of the mouth of the shell by the snail at the proper season for its warmth and security, is also performed by a similar but not the same cerate.

Much of what has been observed of snails belongs to shell fish and their shells; mark the defensive armour of the lobster and of the *cockle; look* at the overlappings of the former,

ng the overlappings of a coat of mail ;
contrivance can be so clear or simple
ertion at the back of the oyster of a
s substance, (so strong that even the
a man can with difficulty overpower it
rst wounding the animal,) that becomes
he ligament that binds the two shells
and the *hinge* upon which they open

ces as numerous as insects themselves
adduced, demonstrative of the wisdom
ness of the Almighty in the formation
ne preservation of his creatures, and
r we might extend our researches, the
l more should we become impressed
der and delight at the infinite and nice
ents made by the Divine Hand through-
on. Were we to compare the simplest
arrangements with the most exquisite
s of imitative art, we should find them
surpassing and superior, but should
pt to examine the more perfect kinds
l forms, the mind would lose itself in
nent at the wonderful mechanism and
diversity of means taken to accomplish
least as well as the more important
of animal economy. The life of man
cely allow him time to enumerate, much
xamine the instances of divine wisdom,
hall therefore dismiss the subject, after
few brief observations in the succeed-
ter on the higher classes of organized

ZOOLOGY.

(Continued.)

Oh! thou all-glorious and eternal volume,
Spread for the sun to smile upon by day,
And the pale moon to pore in pensiveness
And holy contemplation through the night,
Beneath the patient watching of the stars—
From clime to clime, e'en as from page to page
I turn, I find it full of beauty—full
Of unsurpassing excellence, and all
Replete with deathless harmony: Yet Man
That should be as the pitch note to each sound,
And master key of all the instrument,
Is out of tune and harsh. The blooming face
Of changeless nature, from creation's hour
Hath scarcely ceased to smile, excepting when
At man's transgression it was stirred by storm
And terrible convulsion—This is left,
This everlasting record, glorious book,
Whose title-page is love—whose Author, God—
And unto which each beam of the bright sun
Is note and comment daily, this is spurned,
And Mahomet and Sevah, Buddh and Foh,
Reign o'er their millions. Yet there has been know
From the Eternal Saviour, Lord, and God,
And felt, and oh! enjoyed from age to age,
Throughout the dreary solitude of years
In which the world has reeled benighted, or
With horror's gorgon visage for her sun,
A ray of light divine, a soul of fire
Pervading this gross clay, and ministering
To the galled spirit, and the broken heart,
A holy guidance to a brighter world,
Though dimly shadowed and but faintly seen—
A beacon light upon the heaving waves

despair—a taper in the gloom
ank dungeon, and a star that sheds
on the path that leads to heaven.
it's influence, the Godhead's love,
h hath been a soother from the hour
rst from Eden's gates our erring sire
o this thorny wilderness ; a power
ver yet hath failed, though dreadful war
ook the earth a thousand times, to pour
eace into the heart of man,
a rapturous communion
l with the Omnipotent, endowed
pure joys of his celestial world :
ure, even nature hath the charm
le with this wondrous influence
athy : 'tis stirring with the breeze
s the gentle violet from its bed
st green, to gaze upon the sun ;
with the sweet sunset, with the dews
ng's saintly close ; it dwells amid
kened solitude's most awful stillness,
ight's sanctity, and at midnight
the breathless silence. Nor alone
e beauties of a world so fair
t deep influence : the barrenness
le wastes denies it not; the sands
ar no mark save those of savageness,
it aloud ; the child of nature finds
ing on his bosom with the stars,
the heart of passion, as the sun
s some thunder cloud to beauteous tears,
nid which the smiles of heaven blend
ow glory. Faint not then, heart of man,
ill come to thee : have faith, be still,
hall bless thee ; yea, shall purge the dross
g nature, like refiners' fire ;
piercing like a sword, it yet shall heal
nd it makes, and although muttering
geance of Omnipotence, it still
a Comforter, and speak of Peace!

CHAPTER III.

Ears of Animals — Eyes — Bones of Birds — Lungs of Birds — Structure of the Feather.—Feet of Water Fowl.—Stomachs and Gizzards of Birds.—Air Bladder of Fish.—Stomach of the Camel. — Bag of the Oppossum. — Wing of the Bat.—Tongue of the Woodpecker.—Trunk of the Elephant.—Eye of the Chameleon.—Fang of the Viper, &c.

We have given a few instances of Divine wisdom and providential design from the class Insecta; we shall now select at random a few more from the other classes of Zoology. The first wise provision we may notice, and a nice and beautiful one it is, relates to the peculiar manner in which the ears of various animals are situated. Those of beasts of prey, who have to sustain existence by the chase, have their trumpet part or concavity standing forwards, to seize the sounds that are before them, viz. the sounds of the animals they pursue or watch. The ears of animals of flight are turned backwards, to give notice of the approach of an enemy; this is a critical distinction, and well worthy observation. The eyes also of animals that follow their prey by night, as cats, owls, &c. possess a faculty not given to those of other species, namely, the power of closing the pupil entirely, the final cause of which is, that they are able to descry objects with very small degrees of light. The bones of birds may also be adduced as another striking instance of most perfect design which could only proceed from an intelligent Creator. In the bones of an *animal that* was to fly, the two qualities required *would be* strength and lightness, therefore a

large portion of the bones of birds differ from those of walking animals by being *cylindrical*, with their cavities empty, or containing air, and by the shell being made of a firmer texture than that of other bones, to compensate for the want of solidity. Now it is a thing well understood in mechanics, that the same weight or portion of stuff, if made into a cylinder, will be of much greater strength than if worked up in a solid form: thus, without increasing the quantity of bone, which would have added to the animal's weight, and thereby impeded its course through the air, the same strength is produced by merely a different working up of the materials. The lungs also of birds, as compared with the lungs of quadrupeds, contain in them a provision distinguishingly calculated for this same purpose of levitation, namely, a communication between them and the other parts of the body, by which the intromission of air from one to the other at the will of the animal, enables the bird at pleasure to become specifically lighter or heavier as circumstances may require. The structure of the feather also is indicative of the most admirable skill, and is, in fact, a mechanical wonder. First, we have strength and *lightness*. With regard to strength, the feather is only strong when pressed one way, that is, in the same direction the bird takes in the air, but yields easily to the pressure when the finger acts in the same manner that the air does when the bird is flying through it. Besides this, the feather possesses the property, after having been ever so discomposed and ruffled

for all its parts to fall naturally into their former state of closeness and adhesion, without any glutinous matter to assist them: and now for the mechanism by which this is effected. Upon examination we find, first, that the feather is composed of a stem or stalk, with thin threads or laminæ growing out of it on either side, and that these laminæ are flat, and placed with their flat sides towards each other, and as it were interlaced together; this interlacing is performed by means of a vast number of fibres or teeth, which the laminæ shoot forward on *each side*, and which hook or grapple together; fifty of these fibres have been counted in the tenth of an inch; these fibres are crooked, but yet curved after a different manner; those which proceed from the thread on the side towards the extremity of the feather are longer, more flexible, and bent downward, whereas those which proceed from the side towards the beginning or quill end of the feather, are shorter, firmer, and turn upwards; the process then which takes place is as follows: when two laminæ are pressed together, so that these long fibres are forced far enough over the short ones, *their* crooked parts fall into the cavity made by the crooked parts of the others, just as the latch that is fastened to a door enters into the catch, and there hooking itself fastens the door; thus, when one thread or lamina has been separated by any external violence, it is reclasped with the greatest facility and expedition.[1] Without such an arrange-

[1] Paley.

ıent, the contingencies to which birds are sub-
ect in their element, from storms, &c. would
ave prevented their being long upon the wing,
nd every other part of their structure would
ave been of no use to them.

The oil with which birds prune their feathers
s also a beautiful instance of the provision made
y the Creator for his creatures: on each side of
he rump of birds is found a small nipple, yield-
ıg upon pressure an oily substance, which the
ird extracts by pinching the pap with its bill.
With this oil the bird dresses its coat as a defence
gainst the weather. The gland, the pap, the
ature of the excreted substance, are all evidence
f design and intention, beautiful and instructive.

The correspondence between the stomachs
f birds and the organs by which they procure
heir food, is likewise undeviating and uni-
ersal; a bill and a gizzard are always found
ogether, and the gizzard is only common to
raminivorous and herbivorous birds; all these
re furnished with this peculiar and most pow-
rful muscle, the inner coats of which are filled
p with rough plait, which by a strong friction
gainst each other, aided by sand or grit in-
roduced instinctively by the animal, break and
rind the hard aliment as effectually, and by
he same mechanical action as a coffee-mill
vould do. It has been proved by the most
orrect experiments, that the gastric juice (which
s a solvent to all taken into the stomachs of
nimals) in these birds will not operate upon the
rain *whole*, nor even when softened by water
' *macerated* in the crop, therefore, without a

grinding machine in its body, without the trituration of the gizzard, a chicken would be starved on a heap of corn. Now, the gastric juice of a bird of prey acts upon the animal fibre alone, and will not act upon seeds or grasses at all. Thus the constitution of the stomach agrees exactly with the form of the members, and an exact agreement subsists between the *external* organs of an animal by which it procures its food, and the internal powers by which it digests it. The soft membraneous stomach accompanies a hooked notched beak, short muscular legs, strong sharp crooked talons; the cartilaginous stomach attends that conformation of bills and toes which restrains the bird from the picking of seeds and the cropping of plants, arrangements all of them clearly mechanical and beautiful.

A similar provision to the cylindrical bones of birds, and the transmission of air to them for the purpose of rendering the animal lighter or heavier at pleasure, is the air bladder of fish, which is a clear philosophical apparatus in the body of an animal; the principle of contrivance is so clear, and the application of the principle so clear likewise, that it is at once understood by the reflecting mind. The rising and sinking of a fish in the water, so far as it is independent of the fins and tail, can only be regulated by the specific gravity of the body; when the bladder contained in the body of the fish is contracted, which the fish has a muscular power of doing, the bulk of the fish is contracted along with it, and according to the known laws of hydrostatics, the fish being reduced in bulk and the specific

gravity increased, it descends; when, on the contrary, the fish suffers, by the relaxation of its muscles, the uncompressed air to restore the bladder to its usual dimensions, it by the same law rises to the surface.

The stomach of the camel is too peculiar to be passed by; it is well known to return large quantities of water in a pure state for a considerable length of time, which qualifies it for living in the desert. Now the internal organization by which a faculty so rare and so beneficial depends is as follows: a number of distinct sacks or bags (in a dromedary thirty of these have been counted) are observed to lie between the membranes of the second stomach, and to open into the stomach near the top by small square apertures; through these orifices, after the stomach is full, the annexed bags are filled from it, and the water so deposited is in the first place not liable to pass into the intestines, in the second place is kept separate from the solid aliment, and, in the third place, is out of the reach of the digestive action of the stomach, or of mixture with the gastric juice; in addition to this, the animal, by the conformation of its muscles, has the power of forcing this water from the adjoining bags into the stomach, whenever thirst excites it to put this power into action.

The bag of the opossum is a similar curious contrivance. A false skin under the belly of the animal forms a pouch, into which the young litter are received at their birth, where they have an easy and constant access to the teats; in this they are transported by their parent from place

to place, and are at liberty to run in and out, and where they are sure of a refuge from surprise and danger; it is their cradle, their asylum, and their carriage. The structure thus formed is not a mere collapsing of the skin, but a perfect organ by itself, with bones and muscles of its own. Two bones are placed before the os pubis, and joined to that bone as their base; these support and give a fixture to the muscles which serve to open the bag; to these muscles there are antagonists, which serve in the same manner to shut it, and this office they perform so exactly, that in the living animal the opening can scarcely be discerned, except when the sides are forcibly drawn asunder.

The hook in the wing of a bat is both a mechanical and compensatory contrivance; at the angle of its wing there is a bent claw exactly in the form of a hook, by which the bat attaches itself to the sides of rocks, caves, and buildings, laying hold of crevices, chinks, &c.; it hooks itself by this claw, remains suspended by it, and takes its flight from this position, which operations compensate for the decrepitude of its legs and feet. Without the hook the bat would be the most helpless of all animals; she can neither run upon her feet, nor raise herself upon the ground; these inabilities are made up to her by the contrivance in her wing, and in placing a claw on the part the Creator has deviated from the analogy observed in winged animals; a singular *defect* required a singular substitute.

We might go on particularizing similar instances of the care and provision of the Al-

mighty for his creatures through every part of the animal creation. The boring bill and the tongue of the woodpecker, which is tipt with a bony point, and barbed on the sides, — the fang of the viper, lying down upon the jaw, but furnished with a muscle, by which it is suddenly erected, and its bag of poison lying beneath, which discharges itself through a tube into the wound—the trunk of the elephant, compensating for the shortness of the neck of that animal, with its most curious mechanical construction, turning, contracting, and lengthening it at pleasure, with the superaddition of a finger at the and, in which the sense of touch is most delicate—the upper beak of the parrot, which is made moveable to sssist the bird in climbing, and to compensate for the smallness of the under jaw—the eye of the chameleon, which, instead of two eyelids, is covered with an eyelid with a hole in it, which enables the animal to keep its protuberant eye partly under cover, and to preserve it in a due state of humidity, without shutting out the light, or without performing every moment a nictation which, from the protuberance of the eye, would be laborious and difficult—the notches in the bills and claws of fishing birds, to enable them to hold their prey;—all these and an infinite number of similar provisions might be adduced, to establish the wisdom, care, and goodness of the Creator: but beyond all these this will perhaps be better displayed in a brief outline of the mechanism of the human structure, and the use, harmony, *and beauty of* its several parts.

ZOOLOGY.

(Continued.)

Thou matchless piece of harmony and skill
Divine! Focus of bright perfection! Likeness
Of the Most High and Lofty One, whose Name
Is holy, and whose glory is for ever!
Oh! the gross taint of that primeval sin,
What has it made thee? Answer for him, earth,
For thou hast long been desolate beneath
His frantic tread of tyranny, Amid
Thy green and smiling vales, fierce multitudes
Have preyed on multitudes, and millions slain
Their millions. Oh! there is no quiet spot
Upon thy once fair bosom, that hath not
Been scar'd with evil deeds. Thy desert wilds—
Thy craggy dens—thy rocks—thy wizard glens—
From whence the tiger and the wolf were driven,
But to make room for beings far more fierce
And furious than they—bear witness to
Thy wrongs against great nature, and against
High heaven, whose face hath been a thousand times
Red with the reeking vapour of hot blood
From his vindictive arm. Empires that rose
Fair from the simple ages of the world,
Like beauty's fabled type from out the foam
Of the salt sea, have fallen down in strife,
Merciless massacre and death; while kings
Have sat upon their thrones all stiff and pale
With horror. Answer for him too, ye plains,
Now smiling in the sun; for ye have quaked
From age to age beneath the iron tread
Of marshalled hosts, and shuddered with the rush
Of the rude battle shock, while havoc rode
Astride on snorting vengeance, over piles
Of dead, and through a sea of blood. And ye

everlasting mountains, whose white peaks,
saints clothed in their beatific robes,
to hold calm communion with the sky,
emn, silent, awful majesty,
the rack and range of the dread thunder,—
ied bones, more pale than your eternal snows,
from your freezing altitudes, that MAN
is fell minion, hellish War, once held
carnivals upon you ——————
—————— yet. through all,
h prisoned in this brittle vase of dust,
erm eternal, that pure particle
eath divine, called *Soul*, illumined with
ital ray, Almighty,—triumphs still
gh all and in all. Flesh with fanged gripe,
ll the dark contingencies of life;
ll ensnarements of the world, the fierce
emon-hearted passions, cannot bind
nto earth: for she will upwards soar
gh the conflicting tumults and the rage
rtal elements, and smouldering ashes,
ith's eternal wings. Nature fails—her laws
ought,—it is the Spirit—Deity—
hrist enshrined in her eternal essence—
omforter. We scarcely know Thy coming,
hty Father, but we feel Thee lift
beyond mortality: the world
ll its tumults lie like clouds beneath us,
e'er we turn to Thee: earth is a shade—
niverse a phantom—life and death
unreal things—the sun is dim—
right and glowing stars all phantasy—
ou existest to the soul alone,
lorious essence quite pervading hers,
bing all in all; unfailing still,
ill not fail, though earth should be dissolved,
eaven and all her hosts may pass away
breath upon the wind.

CHAPTER IV.

Definition of Bones, Ligaments, Muscles, &c.—Of the Spine—the Ribs—the Joints.—Of the Heart—the Lungs—Stomach, and Process of Digestion.—Of the Muscles, the Arteries, and Veins.—The Circulation of the Blood, &c.

It was the beautiful mechanism of the human frame when contemplated by the philosopher, that convinced him of the being of a God; and indeed, although every part of nature loudly proclaims the Divinity, yet in the human frame we have perhaps a more perfect map of His wisdom, and one which we can follow to a greater extent, before the understanding becomes overpowered. Without an attempt to enter upon anatomy, we will, therefore, bring forward a few striking instances of mechanical contrivance displayed in certain divisions of the human frame.

We may for the sake of brevity divide the human frame into 1st. the Frame Work or Bones; 2nd. the Internal Organization; 3rd. the muscles, veins, &c.

DEFINITIONS OF BONES, LIGAMENTS, MUSCLES, &C.

The *Bones* of the human frame serve several purposes; to support the body, to render it capable of motion, and partly to protect the more material parts. The back bone illustrates the first of these positions; the arms and legs the second; and the scull bone, ribs, breast, &c. the third.

The *Ligaments* are strong inelastic substances, *for holding* together such bones as have motion; *and in* some instances, as in the wrist and in-

p, they bind down the tendons or muscles increase their strength of action.

The *Muscles* are distinct portions of flesh, ich by contracting perform the motions of the ly. *Tendons* are the same fibres more closely nected, that they may possess less space in mb, and be inserted in less room into a bone. muscles end in tendons.

Cartilage, commonly called gristle, is a com- t elastic substance, almost insensible. With the extremities of bones are covered when nded to move upon each other, as in all the nts of the body; this having a fine polished face, renders it insensible of friction, or rather vents it; and by its elasticity prevents the uries which would otherwise be inflicted on joints on many occasions.

Membranes are the most delicately constructed ts of the animal machine; they form the most both and advantageous linings to the several ities of the body. The brain is included in membrane, (the *dura mater*,) which lines the ity of the scull; the chest is also lined with membrane called *pleura*; the abdomen is in manner lined with a similar one, called *itoneum*; the stomach and intestines are also mposed of several distinct membranes or coats, h their vessels and nerves, connected by a mbrane called *mesentery*.

Cellular Membrane is so generally dispersed ough the animal structure, that, like the cel- r tissue in plants, (see page 253,) it seems e the general connecting medium. By this *expanded* membranes are connected to the

parts they line, the coats of vessels are attached to each other; and even the fibres of muscles are united by the medium of cellular membrane. The skin of the body is every where covered with a fine but insensible membrane, called cuticle; between this and the thick skin called cutis is spread a tender substance, which from the slightness of its texture can scarcely be called a membrane, named reté mucosum; upon this depends the various complexions of different persons.

The *Arteries* are large vessels, that convey the blood impelled from the heart into the remotest parts of the body; and the *Veins* are a set of vessels rising among the remoter or finer parts of the arteries, that bring the blood back again.

The *Nerves*, of which ten principal pair are enumerated, are like little white cords; they proceed from the brain, and distribute themselves over the whole body; they include a kind of medullary substance, like that of the brain, and are the organs of sense and motion to the whole machine. The finest visible nerves under the most powerful microscope appear to be only bundles of still finer ones, so that the smallest yet discovered have been computed to be 30,000 times finer than a hair.

Of the Bones.—The largest and most curious bone or series of bones in the body, is the spine or back bone, being a chain of joints of very wonderful construction; it possesses at once the *greatest strength* and the greatest flexibility, *bearing the* weight, or at times six times the

weight of the whole body, and yet allowing of the bending of the trunk in all directions, at the same time that it is a pipe and conduit for the safe conveyance from the brain of the most important fluid of the animal frame, namely, that upon which all voluntary motion depends, the spinal marrow, a substance so tender, that the least wound of it is followed by paralysis or death. The spine not only furnishes the main trunk for the conveyance of this precious substance, but gives out small pipes therefrom for the supply of the nerves to the remotest parts of the body; it also furnishes a fulcrum, stay, or basis for the insertion of the muscles spread over the trunk of the body, and likewise a support for the ends of the ribs to rest upon.

The *Ribs* are articulated to the back bone; but it may be remarked that, in their natural position, they bend or slope from the place of articulation downwards; and the basis upon which they rest at this end being fixed, the consequence of the obliquity is, that when they come to move, whatever pulls the ribs upwards necessarily at the same time draws them out, and that whilst the ribs are brought to a right angle with the spine behind, the sternum or part of the chest to which they are attached in front is thrust forward; the simple action, therefore, of the elevating muscles does the business, whereas, if the ribs had been articulated with the bodies of the vertebræ at right angles, the cavity of the thorax would never have been further enlarged by a change of the *position*: if each rib had been a fixed *bone, the whole* chest had been immoveable

strong string like ligament is inserted by one end into the head of the ball, by the other into the bottom of the cup, which ligament keeps the two parts of the joint so firmly in their place, that none of the motions which the limb naturally performs, none of the jerks and twists to which it is ordinarily liable, nothing indeed less than the utmost and most unnatural violence can pull them asunder. Yet, great as is the strength of this ligament, it is so flexible as to oppose no impediment to the suppleness of the joint; by its situation it is also inaccessible to injury from sharp edges. As from its strength it cannot be ruptured, so from its situation it cannot be cut, except by an accident which would sever the limb: it is, in fact, a contrivance beautifully and unequivocally mechanical, and highly illustrative of the Creator's wisdom.

The ball and socket joint at the shoulder, compared with the joint at the hip, discovers a difference in their form and proportions well suited to the different offices which the limbs have to execute. The cup or socket at the shoulder is much shallower and flatter than it is at the hip, and is also in part formed of cartilage set round the rim of the cup, which contributes more to a free motion and wide range, both of which the arm wants; whereas the lower limb forming a part of the base of the body, having to support the body as well as to move it, firmness was to be consulted as well as action; *hence* the deeper excavation of the socket, and *the presence* of a less proportion of cartilage *upon the* edge.

In all the joints the ends of the bones which work against each other are tipped with gristle to prevent friction; in the ball and socket joint the cup is lined and the ball capped with it. In some joints, such as the knee, there are loose cartilages or gristle between the bones and within the joints, so that the ends of the bones, instead of working upon each other, work upon the intermediate cartilages, to take off the effects of sudden shocks in jumping, running, &c. But another more important provision manifestly adapted to their use is the regular supply of a mucilaginous matter called sinovia, more emollient and slippery than oil itself, which is constantly softening and lubricating the parts that rub against each other, and thereby diminishing the excessive friction in machinery of such constant use. For the continued secretion of this important liniment there are glands near the joint, and for feeding the joint with it, excretory ducts hanging like fringes within the cavity of the parts through which the sinovia passes. Thus we see every provision made—first for the wear and tear, by the polish of the cartilaginous surfaces—secondly, by the healing lubrications of the mucilage—and thirdly, by that astonishing property of animal constitution, which restores the waste as it occurs: and there is nothing, perhaps, that ought to move our gratitude more than the reflection *how well they wear:* a limb shall swing upon its hinges, or play upon its socket, many hundred times in an hour for sixty years together, with scarcely *any diminution* of its agility.

OF INTERNAL ORGANIZATION.

The internal structure of the human body next deserves our attention; and the wisdom of the Creator, saith Hamburgher, is in nothing seen more gloriously than in the heart. The heart is placed in the thorax or breast, and is the spring of motion to the whole machine; the substance of the heart appears to be a series of fleshy fibres, woven together with admirable art; this substance has two inward cavities, which are called *ventricles*, and which are separated from each other by a fleshy partition: here one *vein* is found, which conducts the blood from the upper part of the body into the right ventricle; another which brings back the blood from the lower parts into the same cavity; an *artery*, which sends it into the lungs, and another vein by which it returns from the lungs into the left ventricle, whence it is distributed all over the body by the great artery. On the side of the right ventricle is a sort of cavity or muscular bag, which is called the *auricle*, and which receives the blood before it enters the right ventricle; another auricle, not less useful, hangs at the left ventricle, that the blood may stop there during a new contraction. All the blood passes through the heart, and by it is propelled to every part of the body.[1]

Above the heart, and enclosing it on many points, as the most fitting body, from their softness, to be near so precious a part of the human *frame*, are the *lungs*, which extend on both

[1] Natural Theology.

sides, and nearly fill up the whole capacity of the breast. The lungs are a necessary adjunct to the heart, as it was necessary that the blood should be successively brought into contact with the *air*, for some chemical reason with which we are not yet entirely acquainted; it is however clearly ascertained that the air we breathe consists of two or more parts, one pure and vital, called oxygen, the other noxious to animal life, called nitrogen. The blood being brought into the lungs and there expanded by its minute vessels, (which, in man, is equal to the superficies of 15 feet square,) imbibes a portion of oxygen or pure part of the atmosphere; at the same time it gives out its corrupt air. As soon therefore as the blood is received by the heart from the *veins* of the body, and *before* it is sent out again into the arteries, it is carried by the force of the contraction of the heart, and by means of a secondary and supplementary artery to the lungs, for the purposes named above, and then brought back to be distributed over the body. The pulmonary system is a system within a system, and the action of the heart is the origin of both.

Below the lungs, and separated from it by the diaphragm, the *stomach* is placed; and on the right side is the liver, which separates the bile from the blood, which is afterwards collected in the gall bladder; opposite to the liver is the spleen; behind the liver and the spleen are the reins or kidneys, which separate from the mass of the blood the humours which empty themselves afterwards into the *bladder*. The process of digestion and assi-

milation is as follows: — the food taken into the mouth, after mastication by the teeth, descends by the æsophagus or gullet into the stomach, which lies across the body in the shape of the pouch of a bagpipe; having been received into the stomach by the peculiar contraction of the æsophagus, it is lodged principally in the cardiac extremity of the stomach for a certain period; at this point it is acted upon by the gastric juice, and by its agency is assimilated and converted into a pulpy mass called chyme. Being thus digested and brought to the state of chyme, it passes towards the pyloric end of the stomach; if it is properly mixed, the pylorus, or passage by which it leaves the stomach, opens to receive it; but if it is not properly digested, the pylorus is contracted, and it is forced back into the stomach, to be further acted upon by the gastric juice, which is formed, or rather poured out from the whole surface of the stomach upon the masticated food. The duodenum, having received the food thus assimilated and converted into chyme, it there becomes mixed with bile from the liver, and pancreatic juice from the sweetbread; after this admixture has taken place, the digested food undergoes another process, the nourishing part, called chyle, being now separated from the useless, as it passes assisted by the peristaltic motion of the intestines, from the duodenum along the canals of the viscera. This separation of the useful from the useless parts of the food, is made by innumerable vessels, as *fine as hairs*, arising from the internal surface *of the viscera*; these, after uniting into larger

branches, run into what is called the mesenteric gland, from which other vessels carry it into a common receptacle, called the receptaculum chyli, and from this vessel a duct called the thoracic duct, ascending in an upright position up the back part of the chest along to the gullet, discharges it near the neck into the subclavian vein, where mixing with the blood, it is speedily carried to the heart. In the course through the small intestines the whole of the chyle is usually taken up by the absorbents; but to provide against any accident that might retard the taking up of the whole of the chyle in these, when the mass remaining is thrown into the large intestines, the inner surface of the cells of the colon is also provided with absorbent vessels or glands, which take up the remaining part; these take the same course as the former, terminating in the thoracic duct; the remaining mass is then passed into the rectum, &c. and expelled the body. The chyle apparently enters the blood in an odd place, at a large vein in the neck; but this is for the purpose of bringing it more quickly to the heart, for had the chyle entered the blood at an artery, or at a distant vein, the food composed of the old and new materials must have performed a considerable part in the circulation, before it received that churning in the lungs, which appears necessary for that intimate and perfect union of the old blood with the recent chyle.

OF THE MUSCLES.

We defined muscles to be distinct portions of *flesh, which, by con*tracting, performed the mo-

tions of the body; and they, with their tendons, are, in fact, to the human machine, what the rigging is to a ship, used both to steady as well as to put in motion the various machinery. The head maintains its erect posture by the assistance of muscles, and a finger is not bent or straightened without the contraction of two muscles taking place. There is an exact relation between the joint and the muscle that moves it: whatever motion the joint by its mechanical construction is capable of performing, that motion the annexed muscles, by their position, are capable of producing. All muscles act by contraction; their force is exerted in no other way; when the exertion ceases it relaxes itself, that is, it returns to its former state. Every muscle is provided with an adversary; they act like two sawyers in a pit, by an opposite pull; and nothing perhaps can indicate infinite wisdom more, except another property which is common to them, namely, of their being almost universally so disposed, as not to obstruct or interfere with one another's action: now when we reflect upon the number of muscles, little short of 500 known and named, how contiguous they lie to each other, in layers as it were over one another, crossing one another, sometimes imbedded in each other, sometimes perforating each other, yet all having their perfect liberty and full play, we are struck with new astonishment at the wisdom of the arrangement. Sometimes the action of muscles is wanted where there situation would be inconvenient. The muscles that move the fingers, to be near the point of action

should have been placed in the wrist, which would have swelled the part to a clumsy thickness; they are therefore wisely disposed in the arm towards the elbow, and act by long tendons, which, like wires, pass from them to the fingers, in the same manner the muscles that move the toes are placed in the calf of the leg. A contrivance strictly mechanical and indicative of design, is found in the tendons which proceed from the muscles of the leg and arm to the toes and fingers; the long tendon, as it is called, in the foot, which bends the first joint of the toe, passes *through* the short tendon, which bends the second joint, being a *slit* in one tendon to let another pass through it;[1] this course allows to the sinew more liberty, and a more commodious action than it would otherwise have been capable of exerting.

The variety, quickness, and precision, of which muscular motion is capable, is well worthy of observation. The muscles of the tongue are so numerous and so implicated with one another, that they cannot be traced by the nicest dissection; nevertheless, neither the number nor the complexity of its fibres in any wise impedes the rapid articulations of the most fluent orator: or let a person only observe his own hand whilst he is writing, the number of muscles which are brought to bear upon the pen, how the joint, and adjusted operations of several tendons, are concerned in every stroke, yet, that five hundred such strokes are drawn in a minute: not a letter

[1] *Ches.* Anatomy, page 119.

can be turned, without more than one or t
or three muscular contractions; and yet
easily all is performed! It has been obser
that the most important and the most deli
actions are performed in the body by the sma
muscles, and examples are to be found in
muscles which have been discovered in the d
of the ear and the iris of the eye. The tens
of these muscles is astonishing; they are mi
scopic hairs, must be magnified to be visi
yet are they real and effective muscles; and
only such, but the grandest and most prec
of our faculties, sight and hearing, depend u
their health and action.

Many of our most important functions
achieved by the combined help of different n
cles: it has been calculated that a hun
muscles are employed every time we breathe
we take in or let out breath without reflec
what a work is thereby performed. How n
things must go right, for us to be an hou
ease! yet vigour and activity are in a
majority of instances preserved in human bo
notwithstanding that they depend upon so g
a number of instruments of motion, and notw
standing the defect or disorder sometimes
very small instrument, or a single pair, perh
out of the 446 muscles that are employed,
be attended with grievous inconveniency. T
is piety and good sense, Paley observes,
from whom much of the foregoing is taken
the following observations, taken out of
Religious Philosopher:—"With much
passion (says this writer) as well as asto
ment at the goodness of our living Creator

I considered the sad state of a certain gentleman, who, otherwise in good health, wanted the use of those two little muscles that serve to lift up the eyelids, and so had almost lost the use of his sight, being forced, as long as this defect lasted, to shove up his eyelids every moment with his hands." In general we may remark in how small a degree those who enjoy the perfect use of their organs know the comprehensiveness of the blessing, the variety of the obligation: they perceive a result, but they little think of the multitude of concurrences and rectitudes which go to form it.

We have mentioned the manner of construction of the heart, and we now remark upon the disposition of the blood vessels, as far as regards the supply of the body. The body contains two sets of blood vessels, arteries and veins, both having their centre at the heart; the former send the blood out through every part of the body, and the latter, the extremities of each uniting together, brings the blood back again to the fountain from which the motion proceeded. It may be observed that the blood, in going out, passes always from wider into narrower tubes, and in coming back, from narrower into wider; now it is evident, that the impulse and pressure upon the sides of the blood vessel will be much greater in one case than in the other; accordingly, the arteries that carry out the blood are formed of much tougher and stronger coats than the veins that bring it back, indicating most clearly the care and anxiety of the artificer. A *wound or rupture* of an artery would be attended

with serious danger; these vessels are therefore not only defended from injury by their texture, but by every advantage of situation that can be given to them. They are buried in sinuses, or they creep along grooves made for them in the bones; for instance, the under edge of the ribs is sloped and furrowed, solely for the passage of these vessels: sometimes they proceed in channels, protected by stout parapets on either side; which last description is remarkable in the bones of the fingers, these being hollowed out on the under side like a scoop, and with such a concavity, that the finger may be cut across to the bone, without hurting the artery that runs along it. At other times the arteries pass in canals wrought in the substance, and in the very middle of the substance of the bone; this takes place in the lower jaw, and is found where there would otherwise be danger of compressure by sudden curvature. To those who venture their lives in a ship, it has often been said, that there is only an inch board between them and death; but in the body itself, especially in the arterial system, there is, in many parts, only a membrane, a skin, a thread! for which reason this system lies deep in the integuments, whereas the *veins*, in which the mischief that ensues from injuring the coats is much less, lie in general above the arteries, come nearer to the surface, and are more exposed.

The use of the circulation of the blood, that provided for, is probably, amongst other uses, *to distribute* nourishment to the different parts *of the body*. How minute and multiplied

ramifications of the blood vessels for that purpose are, and how thickly spread over at least the superficies of the body, is proved by the single observation, that we cannot prick the point of a pin into the flesh without drawing blood, i. e. without finding a blood vessel. Nor internally is their diffusion less universal; blood vessels run along the surface of membranes, pervade the substance of muscles, penetrate the bones, even into every tooth; we trace through a small hole in the root an *artery* to feed the bone, as well as a *vein* to bring back the spare blood from it, both which, with the addition of an accompanying nerve, form a thread only a little thicker than a horse hair.[1]

We might pursue this subject through volumes, and still find fresh matter for admiration and astonishment, but only one, and that the meanest of the instances here adduced would be sufficient to prove the existence of an Allwise and Benevolent Being. The bones, the muscles, the blood vessels, and another system, that of the nerves, which it was impossible to enter upon, all harmonious and all perfect as they appear, tell the same truth with a thousand tongues; for the mere twinkling of an eye, or the motion of a finger, has been provided for by the most exquisite art. We indeed see the Divinity more clearly through the Gospel, His moral perfections are there developed; nevertheless have the works of nature, when contemplated, every thing in them which can astonish by their great-

[1] Natural Theology.

ness, and delight by their perfection; for, of the vast scale of operation through which our discoveries carry us, at one end we see an Intelligent Power arranging planetary systems, fixing, for instance, the trajectory of Saturn, or constructing a ring of two hundred thousand miles diameter to surround his body, and to be suspended like a magnificent arch over the heads of his inhabitants, and at the other, bending a hooked tooth, concerting and providing an appropriate mechanism for the clasping and reclasping of the filaments of the feathers of the humming bird; affording proof not only of an Intelligent Being, but that that Being, great and wonderful as He is, hath a care and regard for us, insignificant as we may appear and are; for in every nature, and in every portion of nature which we can descry, we find the profoundest attention bestowed upon the minutest, as upon the most stupendous things: the hinges in the wings of an earwig, and the joints of its antennæ, are as highly wrought and as delicately finished as if the Creator had nothing else to finish. We see no signs of diminution of care by multiplicity of objects, or of distraction of thought by variety. Thus those who regard the phenomena of nature with a constant reference to a Supreme Intelligent Author, will scarcely be able to look upon any thing without perceiving its relation to Him; and that, whereas God was seldom in his thoughts, He will, of *necessity*, be continually brought before him, *and the* Universe become a temple, and life one *continued* act of adoration.

PART V.

NATURAL PHILOSOPHY.

Vain is the search of all philosophy,
Its end is darkness, and the greatest truth
That wisdom ever learned, is but to know
That she knows nothing. Science may pretend
To measure out the ocean drops, or count
The moats upon the sunbeam, or the atoms
That make up this huge ball,—may think to dive
Into great nature's mysteries, and seem
To understand her laws: but yet, through all,
Infinitude, eternity, and death,
Mock, with a hollow and a scornful voice,
From the far distant gloom of all that *was*,
And all that *is*, and all that *shall be!* What?
What then is wisdom? Spirits of the dead,
Spirits of the immortal dead, whom high
Philosophy called gloriously to stand
As lights and beacons to the elder world,
Who deified ignoble dust, and gave
Eternity to time; ye that walked by
Illissus, or, mid academic groves,
Held rapturous converse in the hour of noon,
Say, can ye answer? Sage of Samos,[1] thou
Who lifted up the thick and darksome veil
Upon the face of nature, and didst catch
A glimpse of her fair features; and entranced
By her most beauteous lineaments, fell down
To worship her: and thou,[2] whose living words
Bound human kind like iron, through a host
Of centuries dark: and thou,[3] whom schoolmen still

1 *Pythagoras.* 2 Aristotle. 3 Plato.

Will call divine: say, could ye ever find,
Though freighted with Egyptian lore, and stored
With learning of Chaldea, one bright truth,
Like to the meanest that are sparkling now
Upon the Gospel page? The poor, the mean,
Howe'er unlearned in science or her laws,
Now know what ye knew not—they know their God,
Know he is LOVE. Redemption, on the wing
Of his enduring mercy, comes to them,
And nestles in their unscathed bosoms. LIFE,
Eternal life and immortality,
Big with ten thousand joys, beyond the reach
Of this world's minions, holds her citadel
Of faith within their hearts. The gorgeous pomp
Of nature, and the thousand thousand spheres,
All poised so glorious in the crystal air,
The pageantry of earth, and all her thrones,
And glittering palaces, and golden walls,
That made the light of heaven a very shade,
To them are but as mists that hang about
The morn, and fain would clog them as they rise
Upon their everlasting day: and all
That scrutinous philosophy hath given
Unto the deathless page, from year to year
And rolling age to age, is but to them
A glow-worm's torch, hung up against the sun.

Fall prostrate then, oh wisdom! Pride, enwrap
Thy heart in ashes! Science, wake no more
The startling echoes of another world
From nature's deep recesses! lift not up
Thy thought-worn brow upon the midnight sky,
Nor hold a long communion with the stars!
For though they have beheld, in their long reign,
Millions of kingdoms pass away, like piles
Of snow emblazoned by the solar beam,
That glitter as they fade, and myriads
Of men fall with them year by year, like drops
Of rain upon the bosom of the sea,
They shall not see what these poor eyes shall see;
Nor thou—though thou canst count ten thousand suns
Beyond mere mortal ken, and stretch thy view

Into the dread infinitude of space,
And there expatiate in high joy, among
Millions of worlds,—for they shall fail, and all
That earth or nature hath, or space, or time,
Save the imperishable souls of those
Drawn by high love to look upon their God,
And meet Him face to face,—shall be no more:
Then Wisdom blench, and Science cease to soar.

CHAPTER I.

Definition —Sketch of History—Roger Bacon—Lord Bacon—Boyle—Newton.—Of Matter and its Properties — Extension — Impenetrability — Density — Divisibility — Attraction — Repulsion—Elasticity—Motion—Inertia.

Natural Philosophy, otherwise called PHYSICS, is that science which considers the powers of nature, the properties of natural bodies, and their action upon each other.

Roger Bacon, a monk, who resided at Oxford in the twelfth century, was one who, with the old alchemists in search of visionary objects, such as the philosopher's stone, tended much to the advancement of philosophy. Bacon, more than any other man of his times, persisted in experimental chemistry for useful purposes, and, strange as it may appear, speaks, in some part or other of his works, of by far the greater part of the operations now used in that science. Lord Bacon, Chancellor of England in the reign of Charles I. followed the footsteps of his namesake and predecessor; he reduced his principles to a system, and laid it down as a maxim, that it was by experiment alone that any thing in philosophy could be known with certainty; he *therefore traced* out the way in which future *experimentalists* might proceed, and afforded

variety of hints, on which they afterwards improved.

After Lord Bacon came Robert Boyle, who, to his great wisdom added unfeigned piety. He may be considered the father of modern philosophy; he conducted all his enquiries upon experiment alone, he effected much in the analyzation of bodies, made some important discoveries on light and colours, invented the air pump, and laid the foundation for all the modern doctrines concerning the nature of air; in short, there was scarcely a topic of natural philosophy to which he did not lend his attention, and there was scarcely one which he did not improve.

After Boyle followed Newton, who reduced into one grand system all the scattered discoveries of his predecessors: he explained the motions of the heavenly bodies on a principle entirely new, and demonstrated to the world that planetary system which is now universally received. His discoveries in optics, particularly his invention or improvement of the reflecting telescope, and his researches into the nature of vision and the phenomena of light and colours, were remarkable and wonderful. To conclude, he gave body and consistency to natural philosophy, and made it a system of truth, illustrated and proved by experiment: but what renders Newton doubly illustrious is, that he added to the character of the philosopher that of the Christian, and instead of decrying Revelation, and disputing the existence of a God by miserable *sophistry*, gave evidence, by his conversation *and his* writings, that the truths of religion were *of the first* importance in his estimation.

OF MATTER AND ITS PROPERTIES.

MATTER is that substance or being, of which every thing which we can see, hear, or feel, is composed. It is known to us only by its properties, which are—*Extension*, *Form* or *Figure*, *Impenetrability* or *Solidity*, *Density*, *Divisibility*, *Attraction*, *Repulsion*, *Elasticity*, *Motion*, and *Inertia*.

Extension is that property of matter, by which it occupies a certain space. Philosophers have disputed about the shape of the atoms that compose the elementary particles of matter, but all that we know is, that some sorts of matter are capable of being seen, as wood, stone, &c. which depends upon the property they have of not permitting the rays of light to pass through them, but of reflecting them to our eyes. Other kinds of matter cannot be seen, because the rays of light pass through them; of this nature are the gases, and that compound of certain gases, the atmospheric air, which, although perfectly invisible when dry and pure, is nevertheless as much a substance as the hardest stone.

Impenetrability or *Solidity* is that property, by which two bodies cannot occupy the same place at the same time.

Exp. Fill a glass with water, and put a stone in it, and the water is made to run over.

Obs. Some kinds of matter appear exceptions to this rule: salt put in the place of wood in this experiment, is found not to produce the same effects; again, some substances mixed together, take up less room than they did in separate states.

Exp. *Measure* exactly a glass of water and a glass of *spirits of wine*; *mix* them, and they will be found not to

twice fill the glass. Zinc and copper melted together take up also less room. This arises from the interstices between the particles being filled up, and from their closer union.

Obs. Some bodies, when heated, occupy more room than before.

Exp. Partly fill a bladder with air, and place it before a fire, and it will become stiff.

Fill a phial with water, and cork it, then put it in a boiler upon the fire, and the cork will be forced out by the expansion of the water. The particles here remove from each other, and thence occupy more room.

Density is that property of matter, by which a certain quantity occupies a certain space. Wood, lead, sponge, as we know, are all of different densities or weight. Water is the common standard to which the densities of different bodies are referred; we have hence what is called *specific gravity* (see *Hydrostatics*). All matter is more or less porous; the more porous bodies are generally light, and the less so, ponderous or heavy.

Divisibility is that property of matter, by which it is capable of being divided into parts, which may be removed from each other.

Whether matter be infinitely divisible or not, our limited faculties will not enable us to comprehend; the microscope has however revealed wonders to us in this particular; Leeuwenhoeck proved that a grain of sand would cover 125 orifices through which we daily perspire, and gave an account of certain animalcules, so small that 3,000,000,000 of them are not equal to a grain of sand.

Musk, in the small quantity of a single grain, *will scent* a whole room, and give out scent for

several years; $\frac{1}{4}$ of a grain of cochineal will give colour to 16 quarts of water; a grain of silver dissolved, will tinge 18,000 grains of water; a grain of gold may be hammered into the thirty thousandth part of a line in thickness, and will cover 50 square inches; it is computed that 16 ounces of gold may be laid over enough silver wire to circumscribe the earth; a pound of wool may be spun so fine as to extend 168,000 yards, or upwards of 95 miles. The particles of light, for light is a substance, are still more minute: a single lighted candle may be seen for three miles, particles of light must therefore fill the area of that circumference: how numerous must they be!

Attraction is that property by which the parts of bodies are held together. Of our own bodies we might say with the poet, "pulvis et umbra sumus," for they would fall to dust with the least violence or agitation.

The tendency with which the parts of a solid body adhere, depends on the power of attraction between the particles. By a course of experiments the different degrees of tenacity in several solid bodies have been ascertained. A cord or rod of one tenth of an inch in diameter, composed of the following bodies, kept the following weights suspended without breaking:—

A cord of	*lbs.*
Raw flax	37
Horse hair	45
Raw hemp	46
Raw silk	53½

A rod of	*lbs.*
Fir	23
Elm	35
Alder	40
Oak	48
Beech	50
Ash	50
Zinc	18

A rod of	*lbs.*
Lead	29½
Tin	40½
Copper	299
Brass	360
Silver	370
Iron	450
Gold	590

Experiments to shew attraction. Let fall a little water on a sanded floor, or oiled paper, and the particles will keep as near each other as possible, by uniting into globules. Mercury thrown on the table will do the same. Melted lead poured into water has a tendency also to form into globules: small shot are made upon this principle, and by the addition to the lead of a little arsenic, which disposes it to run into spherical drops as it falls from a great height through the air. Put three or four corks to float in a basin of water; they will gradually approach nearer to each other, and the more rapidly as the distance diminishes.[1]

Heat, if sufficiently powerful, overcomes attraction; thus ice is converted into water, and water into steam.

The formation of stones in the bowels of the earth is also by the attraction or cohesion of the fine particles, towards or upon the external surface; thus we often find flint enclosed by aluminous or clayey earth.

Repulsion is a property only assumed for the sake of distinction, and is, in fact, attraction more decidedly demonstrated, in which bodies have a stronger affinity between themselves than for other objects.

Exp. Dip a ball in oil, and pour water round it, and a ditch will be formed round the ball.

Pour water on oiled paper, and it will run off. By this property in oil, water fowl live uninjured by damp in their native element, and birds are enabled to fly through the rain.

Elasticity is a property which some bodies possess, that though they have been bent or compressed, when the cause is removed they recover their former situation.

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[1] The attraction of gravitation has been treated of in the article Astronomy.

Exp. 1. Bend a cane, and remove the hand, it becomes straight.

2. Press a bladder together filled with air, and it will swell out again.

3. Stretch a piece of Indian rubber, and it will again contract.

It is not easy to say on what this property depends, though attraction seems to have a principal share in producing the effect.

Mobility is that property of matter, by which it is capable of being moved from one place to another.

It is found by experiment and observation, that all matter is capable of being moved, if a sufficient force can be applied for that purpose. "Give me a fulcrum whereon I may rest my lever (cried Archimedes), and I will move the world."

Inertia, or inactivity, is the tendency which bodies have to continue in the same state into which they are put, whether of rest or motion, unless prevented by some external force.

Space is an abstract idea, and can be described only by its want of properties. Space hath no limits or bounds; it consists of parts which may be divided by the mind, but these parts are not capable of actual separation from each other, and it cannot afford any resistance to bodies moving through it. The planetary worlds are said to be poised in space by the Creator.

Space is either absolute or relative.

Absolute space is mere extension; it has no limits or bounds, and is itself immoveable.

Relative space is that part of absolute space which is occupied by any body, and is compared with any other part occupied by another body.

MECHANICS.

Oh! for that glorious hour, when the pure soul,
Enfranchised and made perfect by its Lord,
Shall burst its earthy prison, and mount up
To that eternal world—that happy state
Where WISDOM is perfected, and all things
Are even as they seem; where dust-clogged sense,
And dull and dim infirmity, no more
Can cheat us and deceive. That hour will come,
Yea, swiftly too, and all will be revealed,
All be made clear; no shadows, no thick clouds,
No darkness—but, instead, eternal light,
Revealing all. And this may be a part
Of joy celestial—to have wisdom's eyes
Unscaled to light divine; the Attributes,
Perfection, power, might, will, and majesty,
And the dark counsels, ways, and mysteries
Of the Eternal, all set clear before
The new born faculties. Then shall be seen
Why the oppressor and the bold bad man,
Who trod and triumphed over innocence,
Had the time-serving homage of the world,
And lived in ease and fond security
Thro' lengthened years. Then shall be seen why meek
And lowly piety, who often came
With trembling steps, to pick the fallen crumbs
From the voluptuous board, was sent away
With frowns, and stern upbraidings, and harsh words,
To eat her crust in dreary solitude,
Moistened with tears. Then shall be seen why those
Who hated virtue and who trod on truth,
Who scorned at holiness, and made a mock
At God, were suffered to reign on in sin,
With the world's pleasures bound around their brows,
Like young spring flowers; while the upright and good,
Outcasts upon a heartless world, knew not
Where they might lay their heads. Yes, this may be

Our knowledge then: and feeling this, the soul
Rejoices in the prospect that the hour
Of dissolution is not far away;
For that will shew us all things, and resolve
All seeming contradictions. Faint not then
Ye faithful few, who patient bear the load
And burden still; kiss the chains ye wear,
They are your future ornaments,—the grave
Your door to brighter mansions; yet be calm,
A little longer hope, and raise your eyes,
And it will open you to such a scene
As worldlings ne'er conceived, and saintly eyes
Conceived but dimly. Your world is not
This world I know; its glories and its joys
Belong to other souls—'tis you alone
Exist within yourselves, and nought besides,
Save virtue, hath itself within itself,
To its own essence bright. All knowledge, save
The wisdom from above, is but to you
As foolishness and vanity; ye look
Through faith for brighter issues than the poor
And paltry visions of this fleeting hour,
And languish and expatiate in love
For Heavenly Wisdom, that Great Good alone.

CHAPTER II.

Of Motion—Composition of Forces.—Gravitation.—The Centre of Gravity.—Of the Mechanical Powers—of the Lever—the Wheel and Axle — the Pulley — the Inclined Plane — the Wedge — the Screw. — Of the application of Mechanical Power—Fly Wheels—Friction—Of the Pendulum.

That branch of Natural Philosophy which treats of the motion of solid bodies, is called MECHANICS.

Motion is either absolute or relative. Absolute motion is the change of a body to another place. Thus of a boat sailing down a river: in such a case those in the boat, while *they have absolute* motion along with the boat,

are relatively at rest with regard to the others with them in the boat. It is in vain to investigate the intimate nature of motion, or to endeavour to ascertain in what manner it was originally produced, how it is continued, and how it is communicated from one body to another. Various have been the speculations of philosophers upon the subject; some have considered it a property essential to matter, whilst others have supposed it foreign to its nature, and originally impressed upon it by the great Author of all things.

The disquisition of Natural Philosophy must, however, begin with the consideration of motion, carefully noticing every affection or quality of it, so as to establish marks and measures of every change of which it is susceptible.

The laws by which all motion is regulated may be reduced to three, which may with propriety be called the laws of human judgment with respect to motion; they are

1. Every body preserves in a state of rest, or of uniform rectilineal motion, unless affected by some moving force.

2. Every change of motion is always proportional to the degree of the moving force by which it is produced, and it is made in the line of direction in which that force is impressed.

3. That action and reaction are always equal and contrary, or the mutual actions of two bodies upon each other are always equal, and directed to contrary parts.

To the first of these axioms we say, a stone *will never* move from the ground without some *one moves* it, and that once put in motion it will

preserve that motion, until some other power operates upon it in a contrary direction; this power is generally the earth's attraction, or friction proceeding from it. It is from this law that the motion of the earth and planets, and their satellites, is produced; the great First Cause has set them in motion, and till compelled by Him to stop they will not cease to go on.

To the second we may observe—point a gun in a certain direction, and the shot flies that way; increase the charge, and it flies farther. If a boat be impelled by four oars instead of two, it goes twice as fast, &c.

To the third we may remark—if a man in a boat shove off another boat which comes near him, his own boat is equally moved from its place; if a man in a boat lay hold of a rope fastened to another boat, and pull it, both boats draw near to each other. The ascent of birds by flying is produced by re-action; they elevate the edge of their wings in rising them, and expand them when they strike them downwards, and the reaction of the air raises them up. To shew the force of re-action, a person may lie down on his back, and take an anvil on his breast, which may be beaten with immense sledge hammers, and yet no injury be produced, whilst one such blow without the protection of the anvil would prove fatal.

Composition of forces. When a body is acted upon by two forces at the same time, the one of which would carry it in one direction, and the other in another, they will move it in neither, but in a *line* between the two.

The planets are kept in motion by the action of two forces, the one drawing them to the sun, the other disposing them to fly off in a tangent. The operation of these forces may be shewn by tying a stone at the end of a string, and whirling it round by the hand; the motion given to the stone at the onset disposes it to fly off in a right line, while the controlling influence of the string causes it to move in a circle (see *Astronomy*, page 29).

Gravitation. All bodies near the earth are drawn to it, and in a direct line towards its centre, and will fall so many feet in the first second, 3 times as many in the second, 5 times as many in the third, 7 times as many in the fourth, &c. By experiment it has been found that a body falls 16ft. 1in. in the first second; in 2 seconds therefore it will fall 64ft. 4in.; in 3 seconds 144ft. 9in.; and in 4 seconds 257ft. 4in. The ratio at which gravity decreases is as the square of the distance; thus a body 4,000 miles from the surface of the earth, being twice as far from the centre as it would be at the surface, would weigh only a fourth part of what it usually does; at 8,000 miles from the surface, or three semi-diameters from the centre, it would weigh only one-ninth what it usually does; if as far as the moon, or sixty semi-diameters, it would weigh only the three thousand six hundredth part, $60 \times 60 = 3600$. Actual observation, and calculation shew how far the orbit of the moon falls from the straight line, and exactly coincide with the principle laid down, and prove its truth (see *Planetary Laws*, page 27).

Of the centre of gravity. The centre of gravity is that part of a body around which the other parts are so equally balanced, that if it be supported the whole body will be so too. The centre of gravity in a board may be found by suspending it by the corner, from which a weight is let fall at the end of a string, and marking the line along which the string goes, then doing the same from another corner, the point of intersection will be the centre of gravity. The reason why it may be thus found is, that it always descends as far as possible, and therefore was in the line in which a weight was suspended in both cases.

In our ordinary actions we regulate the motion of our bodies instinctively, as if we were the most correctly studying the effects of the centre of gravity. If a man wishes to rise from a chair, he throws his body forward, otherwise it would be impossible; and if he is likely to fall on one side, he leans on the other; if he carries a load on his back, he leans forward; if at his breast, he leans backward. Rope dancers perform astonishing feats by the assistance of a long pole, with very weighty pieces of lead at each end, by which they balance themselves, and recover firm footing if likely to fall on either side.

The Creator has wisely and wonderfully adapted the construction of animal bodies, with regard to the centre of gravity, to correspond with their modes of life. In ducks, geese, and swans, which are adapted for swimming, the centre of gravity lies pretty far forward; in cats, and animals that spring upon their prey, the

centre of gravity is so situated, that they uniformly drop on their feet; when dropping from a height they hang down the fore and hind foot and tail, so as to bring the centre of gravity to a point below their breast, which, descending first, makes them fall as they do.

Experiments. Fasten a piece of lead to the inside of a drum, or even a pill box, then lay it on the sloping side of a desk or table, and it may be made to appear to roll up for a little way, the lead in reality descending lower and causing the effect.

Put a bit of lead in the pith of elder, cut so as the top part shall be broader than the lower, where the lead is put. If tossed up, the figure will always fall on the weighty end, and if thrown down by the finger it will recover its position.

OF THE MECHANICAL POWERS.

The mechanical powers are simple engines, that enable men to raise weights, to move heavy bodies, and to overcome resistances which they could not do with their natural strength alone. They are six in number; the names by which we designate them are as follow :—1, the lever; 2, the wheel and axle; 3, the pulley; 4, the inclined plane; 5, the wedge; 6, the screw.

Every machine is composed of one or more of these powers, and sometimes of several of them combined; indeed these six powers may be reduced to two, for the pulley and the wheel are only assemblages of levers, and the wedge and screw are inclined planes.

OF THE LEVER.

The lever is the simplest of all machines, and *is only* a straight bar of iron, of wood, or some *other* material, supported on and moveable round *a prop,* which is called a fulcrum.

In the lever three things are to be attended to; 1st. the power which presses on the lever; 2nd. the weight to be raised; and 3rd. the situation of the fulcrum. The advantage results from having the power much farther from the prop than the weight is from it. If the weight to be raised be one foot from the prop, and the power six feet from it, then the weight may be balanced by a power only one-sixth part as heavy; a small additional power will raise it.

To find what power will balance any given weight state the following proportions:—

As the distance between the power and the prop is to the distance between the weight and prop, so is the weight to be raised to the power.

Example. When the power is 12 feet from the prop, and weight 3 feet from it, what power will balance 1,200 lb?

As 12 : 3 :: 1200 : 300 answer.

As the distance between the weight and prop is to the distance between the power and prop, so is the weight.

Example. What weight at 15 inches from the prop, will be balanced by a power of 150lb 75 inches from it?

As 15 : 75 :: 150 : 750 answer.

We distinguish three sorts of levers, according to the different situations of the fulcrum—

First, when the prop is placed between the power and the weight. By levers of this kind a boy opens and shuts the locks of a canal, a seaman moves his rudder, and a blacksmith his bellows; to this also we may refer the handles of pumps, and the common instruments, such as snuffers, pincers, scissors, curling irons, &c. A poker in stirring the fire is also a lever of this sort; the bar of the grate upon which it rests is

the fulcrum, the fire is the weight to be overcome, and the hand is the power to overcome it.

The second kind of lever is, when the prop is at one end of the lever, the power at the other, and the weight between them. Gates and doors may be considered levers of this kind, as may a common pair of bellows, and the oars of a boat. The advantage gained in this kind of lever, as in the first, is as great as the distance of the power from the prop exceeds the distance of the weight. This lever shews too the reason why two men carrying a burthen, as a cask upon a pole between them, may bear unequal shares of weight according to their strength, by shifting the burden farther or nearer to each other. If the pole be 8 feet long, and the cask to weigh 1 cwt. if it be placed precisely in the centre, each man will bear 56lbs. but if placed five times nearer one man than the other, the former will bear five times as much weight as the latter.

The third kind of lever is, when the power is between the weight and the prop. The human arm is a lever of this kind; the prop is the socket at the elbow, the power acts at a small distance from the socket, where the tendon, by the contraction of the muscles, draws up the arm or lets it down. In all levers of the third kind there is a loss of power, but in the case of the human arm the power is generally quite sufficient, and as the hand is thus made to move quickly over a large space, the present state of organization is most useful.

Exp. Lift a chair with the hand, it will be done very *easily*; stretch forth the arm, and the weight will be in-

supportable. Take up a large book, and hold it with the arm extended.

Obs. The wheels of a clock and in watch work are levers of the third kind, the power being by a pinion near the centre, and the resistance acting upon the teeth at the circumference. A common balance depends on its construction on the principles of the lever; and also the steelyard, used in some shops, in which one weight may be put at any distance from the centre on which the balance moves: if the weight at 3 inches distance balance 6 ounces, at 4 inches it will balance 8, at 5 inches it will balance 10, &c.

OF THE WHEEL AND AXLE.

The wheel and axle is a machine much used, and is made in a great variety of forms; it consists of a wheel fixed to an axle or cylinder, so as to turn round together; sometimes a cylinder with projecting spokes, and the power being applied to the circumference of the wheel, the weight to be raised is fastened to a rope, which coils round the axle or cylinder. The wheel and axle may be considered as a kind of perpetual lever, of which the fulcrum is the centre of the axis, and the long and short arms the diameter of the wheel and the diameter of the axis. From this it appears, that the larger the wheel and smaller the axis, the greater is the power of the machine; but then, as is common to every other mechanical contrivance, what is gained in power is lost in time—the weight must rise slower in proportion.

It is proved by geometry[1] that the circumferences of different circles bear the same proportion to each other as their respective diameters

[1] Bonnycastle.

do; consequently the advantage gained by this mechanical power, is in proportion as the circumference or diameter of the wheel is greater than that of the axis: hence the velocity of the power will be to that of the weight, as the circumference of the wheel is to that of the axis.

Example. Suppose a water wheel to be 12 feet diameter, and to turn an axle of 1 foot, the power acting at the circumference of the large wheel moves over 12 times the space which the circumference of the axle moves over; hence 12 cwt. may be raised by the power of 1 cwt.

Windlasses, cranes, wind and water mills, are framed on this principle; the tread-mill lately invented by Mr. Cubitt, is a good illustration.

OF THE PULLEY.

The pulley is a small wheel turning on an axis, with a drawing rope passing over it; the small wheel is usually called a sheave, and is so fixed in a box or block, as to be moveable round a pin passing through its centre.

Pullies are of two kinds, fixed and moveable; the fixed pulley gives no mechanical advantage, but is of great advantage in altering the direction in which it may be applied; the moveable, on the contrary, doubles the power, which may be increased in any ratio whatever by increasing the number of pullies.

In the use of the pulley, or a combination of pullies, the advantage which might be gained is greatly diminished by the friction of the axles and of the ropes. Too complex a combination of pullies would therefore not be of service, as the friction would be increased without a proportional benefit, and from the complexity of the machine would be more liable to be put out of order.

OF THE INCLINED PLANE.

The inclined plane is used for the purpose of facilitating the raising of great weights; it is much easier to roll a cask along a plank into a waggon, than to raise it from the ground.

The force wherewith a body descends upon an inclined plane, is to the force of its absolute gravity, by which it would descend perpendicularly in free space, as the height of the plane is to its length.[1]

When a plane is inclined to the horizon one third of its whole length, any body will be kept from rolling down that plane, by a power equal to a third part of the weight of the body. If the height of the plane be equal to half its length, a power equal to half the weight of the body will support it.

Example. If a plane be 6 feet high, and with a slope of 15 feet, what weight will 150 lbs. sustain?

As 6 : 15 : : 150 : 375 answer.

To calculate what power is necessary to sustain any given weight, we must reverse the proportion.

Example. What power is necessary to balance a weight of 375 lbs., the slope of the plane being 15 feet, and the height 6 feet?

As 15 : 6 : : 375 : 150 answer.

As the friction in the use of the inclined plane is very great, a much less power than that found by calculation will keep a body in equilibrio, and a much greater power will be requisite to draw it upwards.

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[1] *Hutton's* Mathematics.

OF THE WEDGE.

The wedge may be considered as two equally *inclined planes*, united at their bases; and the advantage gained is in proportion as the length of the two sides is greater than the back.

The back of the wedge is struck by a weighty hammer, of which the momentum is given by the velocity of the blow; but the effect produced by forcing in the wedge and raising the weight, is far greater than can be accounted for by any calculation of the effect of mechanic forces or powers.

The Author of nature, whose works uniformly display the utmost wisdom in their design, has formed the beaks of birds wedge shaped, for the purpose of enabling them to dig into the ground, and for breaking the shells of fruit. The whole figure of a bird partakes of this shape, and is thereby adapted for cleaving through the air. Fish also exhibit the same form, which enables them to pass with ease through the water. The breast bones of water fowl are of a proper shape for cutting through their native element, and it is not improbable that the shape of boats and ships might have been by them first suggested.

OF THE SCREW.

The principle of the screw is the same as that of the inclined plane; it is in fact an inclined plane, used with a lever or winch to assist in turning it. The advantage gained by this mechanical power is in proportion as the circumference of the circle made by the lever or winch, *is greater* than the interval or distance between *the spirals* or threads of the screw.

Thus supposing the distance of the spirals to be half an inch, and the length of the winch 12 inches, the circle described by the handle of the winch when the power acts, will be 76 inches nearly, or about 152 half-inches, and consequently 152 times as great as the distance between the spirals; and therefore a power at the handle, whose intensity is equal to no more than a single pound, will balance 152 lbs. acting against the screw; and as much additional force as is equal to overcome the friction, will raise the 152lbs., and the velocity of the power will be to the velocity of the weight, as 152 is to 1.

Hence it appears that the longer the winch is, and the nearer the spirals are to each other, so much the greater is the force of the screw.

OF THE APPLICATION OF MECHANICAL POWER, AND FRICTION.

From the principles delivered above, every one of the mechanical powers is capable of overcoming the greatest possible resistance. This however only holds good in theory; as to bring any of them into practice for the performance of many of those stupendous operations common to our day singly, would be found impossible, as they would frequently be too unwieldy, and thereby unmanageable. For this reason various mechanical powers are combined, and when in this state of combination we term it machinery.

The grand thing to be avoided in all machines is friction; the less complicated therefore a machine is, the less friction will there be. Friction arises from the resistance of one part of a machine against the others, for, however smooth bodies appear to the eye, yet even the most highly polished, when examined by the microscope,

present numerous inequalities, which, rubbing against each other, produce what is termed friction.

To soften and fill up these inequalities, oil, grease, &c. is employed, and friction is then said to be diminished. Friction is increased by increased pressure, or increased velocity.

It is known that two pieces of the same metal working against each other, have greater friction than two pieces of different metals; hence the wheels of clocks and watches have brass pivots working upon steel axles. It is calculated that steel working upon steel loses a fourth, but moving on brass not more than a sixth.

The friction of the lever is very little; that of the wheel and axle is in proportion to the weight, velocity, and diameter of the axle; the smaller the diameter of the axle, the less will be the friction. The friction of pullies is very great, on account of the smallness of their diameters in proportion to that of their axes. In the wedge and screw there is a great deal of friction; screws with sharp threads have more friction than those with square threads, and endless screws have more than either.

Let it not be forgotten that in all machinery what is gained in power is lost in time; no real gain of force is therefore obtained by mechanical contrivances; on the contrary, from friction and other causes, force is always lost; the advantage of machines is, that we are able to give a more convenient direction to the moving power, and *to apply its* action to the body to be moved, *which is of* great importance.

To regulate the motions of machinery fly wheels are introduced. A fly wheel is either a heavy wheel, or cross bar loaded with equal weights; this being made to revolve upon its axis, keeps up the force of the power, and distributes it into all parts of its revolution. The effects of the fly wheel may be easily seen, in turning a common mangle of Baker's construction. The pendulum of a clock acts in degree as a fly.

OF THE PENDULUM.

A pendulum is a heavy body hanging by a string or wire, which is moveable on a centre, and each swing is called a vibration or oscillation. The vibrations are produced by the falling of the weight to the lowest part of the circle, and by the force acquired by the fall.

Galileo was the first who observed that all the vibrations of the same pendulum, whether great or small, are performed nearly in equal times; and the longer a pendulum, the slower are its vibrations, the squares of the times being inversely as the lengths.

Exp. To shew this fasten any weight to the end of a string, and set it vibrating; gradually lengthen the string, and it will be perceived that it requires more and more time. Also get two strings of unequal length, and produce a vibration as before, the shorter will vibrate faster than the other.

A pendulum vibrating seconds in the latitude of London, must be 39·13 inches long; a pendulum vibrating half seconds, must be only a quarter the length of one vibrating seconds. By the *same rule the* length of a pendulum vibrating

2 seconds, must be four times as long as one vibrating seconds, or about 13 feet: the pendulum of the clock at St. Paul's is of this great length.

Heat expands and consequently lengthens pendulums, and cold contracts and shortens them: a pendulum to vibrate seconds must be shorter at the Equator than at the Poles.

As the smallest variation in the length of a pendulum makes a remarkable difference in time, many inventions have been made to correct the contraction and expansion to which pendulums, as all other bodies, are subject from the change of temperature. A pendulum called the gridiron pendulum, is made of alternate bars of brass and steel, and so placed that the expansion of the one corrects the contraction of the other, and thus the centre of oscillation is always kept in the same place.

The centre of oscillation is the point from which the length of the pendulum is estimated: it is in order to bring this point to the end of the rod that the ball is fixed. The time of a pendulum's vibration is not affected by varying its weight, provided we do not shift the place of the centre of oscillation: to prove this—

Exp. Take two pieces of lead, one much heavier than the other, and fasten them to two pieces of string of an equal length, and set them vibrating; they will perform their motions in exactly the same time.

The time of the vibration is not affected by the distance which it swings.

Exp. Set two pendulums in motion as before, but *make one* commence swinging farther than the other; *they will both* keep the same time.

As the length of a pendulum vibrating seconds remains invariably the same, and may at any future period be ascertained, it has been considered as a proper basis for a system of uniform weights and measures; to determine its exact length is then necessary, as even the ten thousandth part of an inch is of consequence. Captain Kater, by numerous and most ingenious experiments, has found it to be in Portland Place, London, 39·13829 inches, and reducing it to the level of the sea, 39·1386 inches. The French metre, the ten millionth part of a quadrant of the earth, was found by him to be 39·37079 inches in length.

It is believed that the motions of the waves of the sea follow the same laws as the pendulum; the force which the wave acquires in its descent, causes it to rise the same height in its ascent.

The pendulum, by its application to clocks and watches, is become of vast importance. Its properties were first demonstrated by Huygens, and it was first brought into use by Dr. Hook.

PNEUMATICS.

We breathe thy vital air, Father of all,
We feel Thy blessed rain-drops and thy dews
Fall sweetly over us at eve or morn:
We hear thy mighty tempests, calling out
From cloud to cloud to magnify thy power
In deeds sublime and glorious: we see
The golden sun march on in pageantry
Of light, from year to year, from age to age,
Pouring his vivifying smile upon the breast
Of the fair earth, which, like a beauteous bride,
Turns all abashed at even from his gaze,
And meets him still with blushes in the morn.—
Day pours her incense from ten thousand springs
Of rich abundance, and the seasons come
With fruits, and flowers, and blessings—but yet Man
Rebels alike through all, and coldly looks
Upon the blue serene of the high heavens,
Clear type of joyous hope and future peace,
And on the verdant earth—yea, idly breathes
The precious balmy air: the golden blaze
Of cheering daylight, and the glittering sheen
Of mists, and clouds, and vapours, throwing back
The solar beams upon the upturned eye,
But seldom reach the bosom: the full pomp
Of the storm's gloomy grandeur, and the deep
And solemn quirings of the thunder peal,
Walking the ocean in the pitch of noon,
To wake the heart up into lordly feelings,
As the young ardent warrior's oft is stirred
By the alarm of the fierce drum: the gloom
And breathless peace of solitude, which comes
Upon the twilight wing of softest down,
To whisper holy thoughts, that might enthrone
Our immortality more firm within us:
And all the sights and sounds from the blue skies,
Descending in the broad day's extacy, or on

The raven wing of midnight, when the stars,
Like heavenly talismans, would seem to charm
And draw us from the earth to higher spheres,
But rarely find from man's hard flinty breast
A holy touch of sympathy. Pomp, power,
The lust of wealth, the vanity of life,
The reign of pleasure, close each avenue
Of that deep core of sensibility,
That answers nature's potent whisperings
With pure unfeigned love. He, wrapped in pride
Of his own darksome thoughts, like the gross worm
That spins itself a blinding panoply
From its own entrails, gropes along in dull
And dark fatuity; or stirred by strife,
Convulsion, and fierce throes of boiling blood,
Scorns heaven and earth, defies the tempest's wrath,
Calls nature, and great nature's GOD—a liar.

Yet Holy Father, thou canst still subdue
All things unto thyself—beyond the yell
Of human tumult, and distraction wild,
And where fierce passions glow, and fury's eye-ball
Dare not intrude, thou sittest all enthroned
In love, and lookest still with pitying eye
On the rude scene around the struggling soul,
And fain would make it like the cloudless sky,
That near thy throne is daily all serene,
Though writhing lightnings sting the haggard air,
And the deep thunder rolls—from all the storms
Of bickering life; and oh! those quaking throes
With which weak flesh in strange convulsion teems,
And the gross fiery particles that move
Our smouldering dust, canst save us, and canst wake
The halcyon note of holy peace within us;
That the heart's blood, which, like a heaving sea,
Doth seem to rise and smite the very heavens
In wild and drunken levity, may fall,
And "PEACE? BE STILL! yet teach it to subside,
Till far expanded, like a mirror pure,
It shews thy glorious presence, beaming fair,
Like the bright sun upon the ocean's calm.

CHAPTER III.

Properties of Air.--Weight—Density—Compressibility.—Air Pump.—Barometer.—Height of the Atmosphere.—&c.

PNEUMATICS is the science which treats of the various properties of the *air*, and of the mechanical properties of aeriform fluids in general, such as their *weight*, *density*, *compressibility*, and *elasticity*.

Those who are unacquainted with the principles of Natural Philosophy would not suppose that the air which surrounds us contained these properties; yet although being perfectly invisible, science has demonstrated that it possesses many properties in common with other solid bodies, and some in which it is found to differ from all other fluids. These properties are—1st. it can be compressed into a much less space than what it naturally possesses; 2nd. it cannot be congealed or fixed, as other fluids may; 3rd. it is of a different density in every part upwards from the earth's surface, decreasing in its weight, bulk for bulk, the higher it rises; 4th. it is of an elastic nature, and the force of its elasticity is equal to its weight.

The weight of the atmosphere exhibits itself like the weight of all solid bodies, by pressure; we are not sensible of this upon our bodies, because the pressure is within as well as without, and because the outward pressure is equal on every part. Many simple experiments will however convince us of the force of this pressure.

It is a common thing to see children amuse themselves with what they term sucking a thimble

on the arm: they place the thimble on a fleshy part of the limb, and then with the breath draw out the air contained underneath; no air being then within the thimble to counterbalance the pressure from without, it is found to be forced down by the weight of the surrounding air into the skin, and can only with difficulty be removed. Another simple experiment illustrative of the same thing is unconsciously performed by boys with a piece of leather, a string and a large stone: the string is drawn through a piece of leather about the size of a half crown, the leather is then wetted and pressed with the foot on a smooth part of the stone; the stone may then be easily lifted, for the force employed to lift it produces a partial vacuum under the leather, and the atmospherical air pressing on the outside makes it firmly adhere.

The weight of air is also demonstrable by experiment.

Exp. Take a hollow copper ball, or other vessel which holds a quart, having a neck to screw on the air pump,[1] and after weighing when full of air, exhaust it, and weigh it when empty, it will be found to have lost 16 grains, which shews that this is the weight of a quart

[1] The air pump is a machine so contrived as to take out or exhaust the air from a glass or any other hollow body. Its invention is ascribed to Otto de Guericke; it was much improved by Mr. Boyle, and afterwards by Dr. Hook. In the exhausted receiver of an air pump all bodies fall with the same rapidity—a feather and a guinea dropped from the top, reach the bottom at the same time. Animals cannot support life in an exhausted receiver, nor can sounds be heard, nor will candles burn in it the smoke of a candle will fall to the bottom.

of air; but a quart of water weighs 14,621 grains; this divided by 16, quotes 914 in round numbers, so that water is 914 times as heavy as air near the surface of the earth.

It is found by means of the barometer, that the weight of a column of air from the surface of the earth to the top of the atmosphere, is on a medium equivalent to the pressure of a column of mercury of equal base, on the tube of the barometer of 29½ inches in length; it therefore follows that, since a cubic inch of quicksilver is found to weigh nearly half a pound avoirdupoise, that the whole 29½ inches, or the weight of the atmosphere on every square inch of surface, is equal to 15 lbs. From this we may calculate the precise pressure upon the human body, for if the whole surface of a man's body be supposed to contain 14 square feet, or 2016 inches, and a column of 29½ inches high and one inch square weighs 15 lbs. the whole pressure will be 30,240 lbs. In this way we may also calculate the whole amount of the pressure on the earth's surface. This contains in round numbers about 200,000,000 square miles, and every square mile contains 27,878,400 square feet, therefore there must be 5,575,680,000,000 of square feet in the earth's surface, which multiplied by 2160 lbs. the pressure on each square foot, gives twelve trillions forty-three thousand four hundred and sixty billions eight hundred thousand millions of pounds for the pressure or whole weight of the atmosphere.

From this weight of the body of the atmos*phere*, which is equal to that of 33 feet of

water, depends the construction of the common pump. Galileo discovered that it was impossible to raise water higher than 33 feet, he therefore concluded that a column of water 33 feet high was a counterpoise to one as high as the atmosphere. It is the same pressure that makes the mercury keep up in the barometer. Galileo's pupil, Torricelli, considered that as mercury was fourteen times as heavy as water, a column of that fluid need only be 1-14th. of the length of one of water, to form an equal counterpoise to the pressure of the air, and accordingly having filled with mercury a glass tube about three feet long, hermetically sealed at one end, he inverted it into a small basin of mercury, and found, as he expected, that the mercury subsided to the height of about 29½ inches, and there remained suspended, leaving at the top of the tube a space or perfect vacuum, which has been called the Torricellian vacuum.

From this column of mercury often varying in height, it was naturally assumed that the pressure of the air was different at different times; it was soon then observed that the changes in the height of the mercury were accompanied, or very quickly succeeded, by alterations in the weather; hence the instrument obtained the name of the weather glass, and from its measuring the height of the atmosphere it is called the barometer.

Air is one of the most elastic bodies in nature, that is, it is easily compressed into less compass, and when the pressure is removed it regains its former bulk.

Exp. Lay a weighty book on a bladder, and blow into it with a pipe, and the book will be raised; increase the weight on the bladder, and you may still raise it as before. A bladder filled with air may be compressed, and the moment the force is removed it will recover its size; if thrown on the ground it will rise like a ball.

By the air pump the elasticity of the air is better shown; for if a bladder, the neck of which is tied fast, be put under the receiver, the small quantity of air enclosed in the bladder will, by its own elastic force, gradually expand itself and at last burst the bladder.

Air is also expanded or rarefied by heat; if the same bladder closely tied be laid before the fire, the heat will so rarefy the air enclosed in it, as to extend the bladder to its utmost stretch, and if continued will cause it to burst with a loud report. Put an empty bottle with a cork in it near the fire, and the cork is drawn out from the same cause.

Air may be condensed by artificial means into fifty thousand times less space than it usually occupies; thus the air compressed in the wind gun will, by its elastic force when discharged, drive a bullet through a board at the distance of 70 or 80 yards. The air by its elasticity will so far dilate or expand itself, as to take up 13,769 times more space than before. A great variety of experiments may be performed by means of condensed air. The sound of a ball is much louder in condensed than in common air: a phial that would bear the pressure of the common atmosphere, when the air is exhausted from *the inside*, will be broken by condensing the air *around* it.

The density of the air is proportional to the force that compresses it. The air is more dense near the earth's surface than in the upper regions, from its bearing the weight of the air above; from this circumstance the heights of mountains are ascertained by the barometer, for every 103 feet the barometer ascends, the mercury falls 1-10th. of an inch, 103 feet of air being equal to 1-10th. of an inch of mercury on the surface of the earth. The barometer at the top of Snowden, in Wales, sinks 3·67 inches, therefore that mountain is 3720 feet in perpendicular height.

The height of our atmosphere has never been exactly ascertained; it is however observed, that at a greater height than 45 miles, it does not refract the rays of light from the sun, and this is usually considered the limit of our atmosphere; it is however presumed, from the appearance of meteors, which have been reckoned to be 70 or 80 miles distant, and whose light is thought to depend upon their coming through our atmosphere, that it may extend to an immense distance, becoming however rarer in proportion to its distance from the earth.

The reason why we cannot see air is because of the minuteness of the particles of which it is composed, and their permitting the rays of light to pass through them, without reflecting any back to us.

Air as well as water is a compound substance; in 100 parts of atmospheric air are 22 parts oxygen and 78 nitrogen; of these two, oxygen is that which supports animal life and combustion.

Air performs a most important part in the economy of nature in regulating the heat of different climes. The tropical regions are refreshed, and their temperature kept from rising to a degree unsupportable to the human frame, by the cool streams of air arriving from the polar regions. On the other hand less favoured climes have the severity of the cold modified by the arrival of warmer gales. These currents of air do not uniformly proceed in a direct line, but whether by a direct or an oblique course, their effect is the same.

The air has also an effect in maintaining an equilibrium of heat by day and night. After the ground has become heated by the incidental rays of the sun, it supports its warmth to the incumbent air, which, becoming expanded, naturally rises, and the cool air from its greater weight descends into its place. Thus cool air accumulates at evening and during the night.

As the air becomes more rarefied, which it does regularly at every successive elevation above the level of the sea, being pressed downwards by fewer superincumbent strata, its capacity for heat becomes in proportion greater; in other words, a greater portion of its heat becomes what is called *latent*, and is neither perceptible to the feelings nor to the thermometer, and is incommunicable to other bodies.

As the air becomes cooler as we ascend from the level of the sea, it follows that when we arrive at a certain height, even on the Equator, *we find* congelation, and as near the Equator *there is* little variation of heat throughout the

year, the lowest height at which congelation is found will be always the same. In the different climes as we approach the Poles, as the mean temperature becomes less and less, so also perpetual frost will be found at a less and less elevation.

The decrease of temperature in ascending the atmosphere is not far from being uniform at the rate of about one degree for every hundred yards of elevation. The mean height of eternal frost under the Equator is 15,207 feet; at 30° latitude is 11,484; and at 60° latitude is 3,818 feet.

Besides atmospheric air there are two other airs, or as they are commonly called gases, which are abundantly produced by nature. One is called carbonic acid gas, sometimes called choke damp and fixed air; the other is hydrogen gas or inflammable air. From the former we often hear of fatal accidents to those who enter deep wells, vaults, and cellars, where fermenting liquors have been kept, and brewers' vats; and it was from the abundance of this gas on its surface, that the Lake of Avernus was in ancient times so destructive to animal life, that birds flying over it were said to drop down. The Grotto del Cane, near Naples, is also remarkable for destroying animal life by this gas.

This gas may easily be obtained by the following means:—Take a piece of chalk or marble, pound it and put it into a phial; then pour upon it water, with a third part sulphuric acid (oil of vitriol), a violent effervescence will then take place, and the gas will be generated in great abundance. As this gas is nearly twice as heavy as common air, it may be poured from one vessel to another as if it were *water*.

Water impregnated with this gas will boil at a less degree of heat than 212, and in a little time the gas will be dissipated.

It is remarkable that this gas, which by itself is so destructive to life, has the most beneficial effects when taken into the stomach combined with liquids. Thus we make use of many mineral springs, whose sole efficacy lies in their containing it, and drink soda water, which to some constitutions is found of great benefit. Bottled porter, bottled cider, &c., owe their superior excellence, in a great measure, to their retaining carbonic acid.

The other gas is called hydrogen gas, and is found very abundantly in nature, and by its explosions in coal mines has often been very destructive. It is used to fill balloons, to burn for light, and philosophical fire works are sometimes made from it.

As its name implies, this gas enters largely into the composition of water, and from the decomposition of that element is found in great abundance. It may be obtained during summer from ditches, or pools of stagnant water, by holding a bottle with a funnel neck downwards under the water, and stirring the bottom of the pool with a stick, when the gas will rise in bubbles into the bottle: it may, however, be more easily obtained in the following manner—

Put a few iron filings into a phial, and pour in a little water mixed with a fourth part of sulphuric acid; great heat will be produced, and the gas will rise out of the *bottle*, and upon the application of a lighted paper will *burn in* a small blue flame.

There is an abundance of hydrogen gas in common coals, and when we see in the fire a small stream of smoke shooting out with great violence, it is the gas making its escape; it is from coals that this gas is obtained for lighting the streets, &c.

To hydrogen gas are owing many natural phenomena: the meteors called falling stones are this gas set on fire in the atmosphere by electricity. The ignis fatuus, or Will-of-the-wisp, is this gas in spontaneous combustion; many philosophers are also of opinion, that the Aurora Borealis is also occasioned by the burning of hydrogen gas in the upper regions.

Hydrogen gas is now used for inflating balloons. The inventor of balloons was Montgolfier, who took his idea from seeing light clouds floating in the atmosphere; he thought that by making a large bag, and filling it with heated air, he could make the whole lighter than the common air; he therefore burnt straw under a bag of vast size, open at the lower end, and the rarefied air passed into it, which rendered the whole so light that it bore up men from the earth. Pilatre des Roziers, and D'Arlandes, were the first who committed themselves to the air, and performed a voyage.

Balloons are now made of silk, prepared in a peculiar manner, and filled with coal gas from the gas works. They may, however, be filled by gas in the manner of the experiment already given. Fire balloons, or those raised by heated air, and small ones, may be made of tissue

paper, with a wire round the bottom, to which a cup containing some cotton and spirits of wine may be attached, the flame of which will rarefy the air and raise the machine.

Notwithstanding the extraordinary nature of balloons, they have been scarcely of any use, and few discoveries have been made through their agency; nor have they extended our knowledge of the atmosphere. A slight difficulty of breathing is experienced as the balloon ascends high up, and the blood vessels of the nose, being less supported by the external pressure, sometimes give way, and bleeding ensues, while the barometer sinks in its usual gradation.

THE DIVING BELL.

This machine was invented for the purpose of enabling persons to remain under water, a supply of air being afforded them from above. The first one of any note was made by Dr. Halley.

It may be illustrated as follows:—

Take a glass tumbler, and plunge it into the water with the mouth downwards, very little water will rise into the tumbler, being prevented by the air contained in it; this air, thus keeping the water from rising above a certain height, is breathed by the persons inside the bell, and a fresh supply is obtained from above by pipes. The diving bell has been used with great success to bring up treasures from the bottom of the sea.

METEOROLOGY.

Forget me not! Forget me not!
Thou utterest, Lord, from earth or skies,
In glittering glory rainbow dyes,
And every breeze that sheds a balm
On morning's joy or evening's calm,
In open glade or lonely spot,
Maintain a tongue to tell thy power,
And whisper in thy name each hour—
Forget me not! Forget me not!

Forget me not! Forget me not!
Thou says't through fragrance, beauty, bloom,
Charming the heart in this deep gloom;
The sun's bright ray, the starry gleam,
And the mild moonlight's tender beam,
On many a wave, in many a grot,
And all the sights and sounds that pour
Rapture that bids the heart adore,
Cry out for Thee—Forget me not!

Forget me not! Forget me not!
The Record of thy will doth say,
Revealing Thee in glory's ray,
On Sinai's mount, with justice crowned,
Throwing thy awful thunders round,
But most, when pitying the hard lot
Of man, thy Son rejoiced to die
Upon the Mount of Calvary,
Thou said'st in love—Forget me not!

Merciful God! forget us not,
When sinking through the weight of woe,
But round us the remembrance throw
Of every comfort, long imparted
Unto the wronged and broken hearted;
And deign, oh! deign to give us what
No earthly powers can e'er invade,
And darkest hours can never shade—
Thy light and peace,—forget us not!

Forget us not! Forget us not!
In that dread hour, when tyrant death
Shall gripe this form and stop its breath,
Oh! in each struggling throe, that clay
Feels when the soul is wrenched away,
And it is left for earth to rot,
Look down in mercy—Lord, be nigh,
To curb the dying agony;
We are but dust—Forget us not!

CHAPTER IV.

Meteors.—Vapours.—Exhalations.—Mists.—Clouds.—Rain.—Snow and Hail.—Dew.—Wind.—Hurricanes.—Tornadoes.—Whirlwinds.—Waterspouts.—Of the Barometer and Thermometer.

Connected in a degree with Pneumatics is the science of METEOROLOGY, which treats of the atmosphere, the alterations that take place in it, its currents of winds, of the variations of its gravity or pressure, of the changes in its temperature, of the state of the electricity which it exhibits, and lastly, as to the visible phenomena dependent upon these changes.

Whatever is engendered in the air which surrounds us, and which appears to be beyond the moon, is a meteor. Meteors are composed of vapours and exhalations.[1]

Vapours are particles of water which mingle with the air.

Exhalations are particles of earth, or the component parts of the earth, the sulphur, salts, bitumens, &c. more or less combustible, solid, or heavy, which rise into the atmosphere.

[1] *For an account* of meteors, hurricanes, &c. see page 115.

Mists are those collections of vapours which chiefly rise from fenny moist places, and become more visible as the light of the day increases.

Clouds are vapours and exhalations from the sea and earth, drawn into the atmosphere by the solar heat. The height of the clouds is supposed to be a quarter of a mile, and the wonderful variety of their colour is from their situation with regard to the sun; their different figures occur from the effects of the winds or various currents of air.

Rain is thick clouds condensed by the cold in the upper regions, which by their own weight fall upon the earth in small quantities, called drops of water.

Snow and hail are the same drops, frozen in their descent towards the earth. In the former the frost catches the resolving cloud, just as its particles are about to unite into drops; and in the latter the drops are actually frozen in their descent.

Dew is produced from a quantity of particles of water, extremely subtile, that float about in a calm and serene air, in the form of vapours, which, being condensed by the coldness of the night, lose by degrees their agitation, and uniting together, fall in the morning in small invisible particles, like an extremely fine and delicate rain.

Wind. When the air is rarefied, it naturally ascends into the higher regions, and the circumjacent air, which is thicker and heavier, immediately rushes in to supply its place and fill

up the vacancy; this motion of the air we call wind.

Hurricanes are sudden and violent gusts of wind, which come on at very irregular periods, and generally continue for a short time. Tornadoes are violent winds attended with particular phenomena, such as droughts, heavy rains, hail, rain, snow, and thunder. A whirlwind is formed when gusts of wind come from different quarters at the same time, and meeting in a certain place, the air acquires a rotatory or screw-like motion round an axis, which is sometimes stationary, and at others moving on in particular directions.

The water-spout is also a phenomena connected with Meteorology; it is an extraordinary aqueous meteor, most frequently observed at sea. It commonly begins by a cloud, at first very small, which mariners call the *squall*; this augments in a little time into an enormous cloud of a cylindrical form, or that of a reversed cone, and produces a noise like an agitated sea; sometimes emitting thunder and lightning, and pouring out large quantities of rain or hail, sufficient to inundate large vessels, overthrow trees and houses, and every thing which stands in the way of its course. Both this and the whirlwind are meteors arising from the same general cause, and are explicable upon principles furnished by electrical experiments and discoveries.

Of the Barometer. The barometer is an instrument intended to shew the weight of the atmosphere at any given place and time, and to *foretel the* changes in the weather. The common

barometer is a glass tube about 2-10ths. of an inch in diameter, and at least 31 inches long. This tube is filled with mercury so as not to have any air over it; the maker placing his finger on the end, immerses it into a basin of quicksilver which has been heated or boiled to take away the air, and then takes his finger away. The quicksilver in the tube, by its own weight, endeavours to descend into that in the basin, but the external air pressing on the surface of the quicksilver in the basin without, and no air being in the tube at top, the quicksilver will continue in the tube, being raised by the pressure of the air on the surface of the basin below to a height corresponding with the weight of the atmosphere at the time; this tube is then fixed into a wooden case, and we have a barometer.

When the atmosphere is heavy, the mercury stands high in the barometer. At that time the clouds and vapours are generally borne high in the atmosphere, and we have clear dry weather. On the other hand, when the mercury falls low, it indicates the lightness of the atmosphere, and as the clouds then generally descend, rain or snow may be then commonly expected. These, however, are only general rules and extremely vague. To use with advantage the barometer as a weather glass, it is necessary to know how the mercury has stood for some days before, and whether it is rising, falling, or stationary. The following rules ought always to be attended to:—

1. The rising of the barometer presages in general fine weather, and its falling foul weather, as rain, snow, high winds, storms, &c.

2. In very hot weather the falling of the mercury foreshews rain.

3. In winter, when the mercury rises, frost may be expected; and in frosty weather, if the mercury falls three or four divisions, there will certainly be a thaw; but in a continued frost, if mercury rise, it will certainly snow.

4. If soon after the falling of the mercury foul weather commences, expect but little of it; and if soon after the rising of the mercury fair weather begin, expect but little of it.

5. In fair weather when the mercury falls much and low, and then continues for two or three days before the rain comes, then expect a great deal of it, and probably high winds.

6. In foul weather when the mercury rises much and high, and so continues for two or three days before the foul weather is quite over, then expect a continuance of fair weather to follow.

7. The unsettled motion of the mercury denotes uncertain and changeable weather.

N. B. It will be useful in ascertaining whether the mercury be rising or falling, to observe if it is concave or hollowed in the middle, as in that case it is falling. On the other hand, if the middle be convex or slightly conical, it denotes the mercury to be rising.

Of the Thermometer. The thermometer shews the changes in the temperature of the atmosphere; it is constructed with a hollow ball of glass, from which arises a long tube partly filled with mercury or coloured spirits of wine. In making the instrument, the bulb filled with the fluid is plunged into boiling water, which causes the spirit or mercury to ascend to its greatest *height*, and at this point the tube is broken off

and hermetically sealed, that is, the neck of the tube being heated, it is twisted together by a pair of hot pincers; and the thermometer, with the addition of a scale, is complete. As the heat is greater or less, the mercury rises or falls, all bodies expanding by heat and contracting by cold.

The honour of the invention of the thermometer has been claimed on behalf of many celebrated philosophers, but it appears to have been invented by Sanctorio about the year 1590. It was brought to a correct standard about the year 1724 by Fahrenheit: it would have been better if he had fixed the beginning of his scale, zero or 0°, at the freezing point of water. The absolute point of total absence of all heat whatever has been supposed to be 1,400 degrees below the commencement of his scale, and the highest possible degree of heat to which any body may be raised, as metals in the furnace, to be about ten times as much above. The degrees of heat of metals in the furnace have been attempted to be measured by means of pieces of clay, on the supposition that they shrunk together, and diminished in bulk in proportion to the degrees of heat to which they were exposed. Wedgwood has the honour of this invention, but its results can never be very accurate.

HYDROSTATICS.

Philosophy—thou wizard! whose deep spells
And direful incantations, and strange charms,
Usurp the mind to madness—unto thee
The ardent and enquiring soul, on fire
With its own longings, turns to lead her on
Through nature's mysteries; and thou dost stand
In spectral glooms and in the shades of night,
With sullen smiles, beckoning thy votary
To follow thee. He follows on in awe,
Trembling and panting in thy mystic looks,
As if thou wert some ghost, endowed with power
To tell the secrets of the grave.——Afar
Through the dread realms of space, where worlds on worlds,
And systems within systems, suns and spheres
Innumerable and infinite, would daze
With glory's full excess the faltering eye,
Thou bearest him in wonder: then again
From heaven to earth descending, like one struck
Down by the lightning; through impervious shades
Of charnelled horror—through deep caves of death,
Where lie the ruins of a former world,
'Mid the black wrecks of things stupendous,
That once had life, but whose uncertain forms
No eye may fashion—thou dost lead him on,
His eye-ball in most terrible dismay
Wide starting. Then in silence, and with wild
And reckless passion, all intent to build
Some system after ages may approve,
He dives into the essences of things
Material—would separate and part
The elements—and atom after atom,
And grain by grain, would decompose and sift
The very dust. Staking his life and soul
On some vague hope, still lured by thy false smile,
He follows on beyond the natural bounds
Of reason—and the undefined and dim
And shadowy visions of the doubtful past,
And the dread future—the two principles,

The two great principles of *Good* and *Evil*—
GOD, soul, existence—death, eternity—
Their mysteries of mysteries confound,
And plunge him to enquiries headlong, wild,
And daring. But thy desolate reply
To all his stern and fiery questionings
Is *silence*—darkness—clogging up the heart
And thickening at its core like stagnant blood—
Death's deep penumbra—the full pomp of gloom—
Closing upon it like a pall! a deep
And terrible eclipse o'er the wide world
Of sentient perception! the mind's day
Turned in its full meridian of glory
Into blank midnight—icy, barren, cold,
Starless, moonless, idealess—ETERNAL NIGHT!

Not like to this ends the research of him
Who humbly walks with nature, and who seeks
For higher, holier, brighter truths than hers,
From God himself revealed—and from that high
And dizzying pinnacle of human thought
Steps to the sacred page, and climbing still
The now illumined ascent, stands firm at last,
Above all sublunary grandeur, like
The prophet upon Pisgah, and looks out
Upon the promised land. The heaven of heavens
Is opened to his stedfast gaze, for that,
Upborne by hope, and strengthened still by faith,
Like the bold eagle's, can look all undazzled
Upon the source of light: and as that bird
Takes the resplendent disc of the clear sun
For his proud mirror daily, so can he
Glass himself fully and unblenchingly
In the high glory of a brighter world,
Even to the end of time; while the pure soul,
By light divine renewed and sanctified—
By GOD himself ineffably illumined,
Cowers in the highest extacy before
The footstool of his Majesty, and views
All His exalted attributes, enshrined
In forms of matchless beauty, radiant with
His smiles, and smiling through the fadeless joy
Of His eternal presence—and she feels
The blessed foretaste of her future joy,

Expatiates and lingers for the hour
When at his bidding she shall be withdrawn,
Sweetly as sunbeams at the close of day
From earth's gross vapours, through the gates of death,
Mingles with essences divine, and tastes
That love celestial, which resolves all ties,
All dear connections with this sinful sphere,
And in one bond of everlasting peace
And perfect union, joins and cements
Her with the heavenly natures: she looks up
Beyond the clouds of every mystery
From error's darkened sky to truth's full beam—
From thralling midnight unto freedom's day—
From gloom to glory, and from *death* to *life*—
Pure, perfect, real, never ending life;
And all her powers are ready for the change,
And she herself is buoyant on the wing—
Faints not, nor falters in the dying hour,—
But with her strength renewed, sustained
By Love Eternal, she mounts upwards still,
Unto the source and centre of all light,
To Light Himself—to Deity—to God!

CHAPTER V.

Pressure of Fluids.—Upward Pressure—Hydrostatic Bellows.—Water Presses.—Specific Gravity.—Hydrostatic Balance.—Hydrometer.—Table of Specific Gravities—Rules for Calculation—Examples, &c.

The science of HYDROSTATICS treats of the weight and equilibrium of fluids *at rest*.

Fluids are of two kinds, non-elastic and incompressible, and elastic and compressible. Water, oil, mercury, &c. are of the former; and air, vapour, and the gases, of the latter.

Fluids, unlike solids, not only press downwards, but also upwards, sideways, and every way alike. Thus it is that water passing *through* pipes is forced up to the level of that *body of* water from which it came; thus fountains *of* immense magnitude have been formed

From the pressure of liquids sideways it is, that if we bore a hole in a vessel filled with water, it will spout out; and from their pressure upwards that a body lighter than water, when thrown into it is observed to swim. If the pressure from below can be taken off a body, though it be specifically lighter than water, it will continue immersed.

Exp. Get two very smooth pieces of wood, and fix one of them to the bottom of a bucket; lay the other piece of wood over the former, and hold it down until water be poured on, and then, although the hand be removed, the piece of wood will not float.

Fluids also press in proportion to their perpendicular height, and the area of the base of vessels containing them. If one cask be in the shape of a cylinder, and another in the shape of a cone, if the bases and the perpendicular height be equal, the pressure is equal, although the solid contents, and consequently the weight of the cone, be only one third that of the cylinder. The pressure of water in a funnel is only that of a column of fluid whose base is the area of the outlet; on the other hand, make the base of a cone the bottom of a vessel of that figure, and the pressure will be the same as if the vessel was of a cylindrical shape, and the bases equal. We may make this subject more familiar by the following experiment:

Exp. Get a bladder, and having filled it with water, put a tobacco-pipe in its neck; lay some books on the bladder, and observe the weight it will bear up when the tobacco-pipe lies horizontally on the table; raise the pipe into a vertical position, and amazing weight will be now sustained.

It is easy to see by this, that a quantity of *fluid however small*, may be made to counter-

poise the greatest quantity. The hydrostatic bellows further exemplify the same thing.

This instrument consists of two pieces of wood, joined together by leather at the sides, like the common bellows, and of a long tube opening into the inside. Water poured into this tube makes the upper board rise with great violence, and a weight of from 3 to 5 cwt. may be sustained by it. One would suppose that the weights would press down the upper board, and make the water spout out of the tube, but this is not the case; a quarter of a pound of water in the tube will balance upwards of 300 lbs. when the bellows are 16 inches long and 18 broad.

Upon this principle a press has been contrived, by the help of which hay, straw, wool, &c. or any light substance which it is desirable to pack into little room, may be forced into small bulk.

The pressure of water against the sides of vessels, canals, rivers, &c. is increased by an increase of depth; the proportion is as the square root of the depth: thus, if water at 1 inch depth be increased to 4 inches, the pressure will be twice as much; if the depth be made 9 inches, it will be three times as much; if 16 inches, four times as much; if 25 inches, five times as much, and so on.

OF SPECIFIC GRAVITY.

The specific gravity of a body is its relative weight to other bodies of the same bulk. It is usual to compare the specific gravities of all bodies with that of water, distilled water of the same temperature being found of the same weight in all parts of the world.

The instrument used for finding the specific *gravities* of bodies is called the hydrostatic *balance*. This differs but little from the com-

non balance, excepting that a hook is attached it the bottom of one of the scales, by which the ubstance to be weighed may be suspended by horse-hair in fluid, without wetting the scales. In these scales the body is first weighed in air, hen afterwards, being suspended by the horse-air, is weighed in water; the weight in water s now subtracted from the weight in air, and the veight in air is divided by the difference thus btained, which gives the specific gravity.

Example. I weighed a piece of stone, and found it to e 560 grains in air; I then suspended it by a thread n a vessel of water, and found it to weigh 360 grains: equired the specific gravity?

gr.	
560	weight in air
360	weight in water
200	difference

ivide 560 by 200, and the answer is 2, 8, and if we eckon water at 1,000, the specific gravity of the stone s 2,800.

Some bodies, such as wood, cork, &c. being ighter than water, the following method must be taken:

Pincers must be provided to keep the substance under water. First weigh the body in air, then having balanced the tongs in water, fix them to the body to be raised, which, being lighter than water, will raise the tongs and cause the other scale to preponderate; observe the loss of the weight in water, and proceed as before.

Another, and perhaps easier method to find the specific gravities of bodies lighter than water, is first to weigh the wood in air, then to weigh in water a piece of metal sufficient to sink it; fasten *this to the* wood, and weigh them both *together in water*, and it will be seen how much

less the wood is weighty than water, and the proportion may be stated.

Example. Suppose a piece of wood weighs in air 16 ounces, and a piece of lead weighed in water 12 ounces, and that when both are fastened together and suspended by a string in water, the weight in water is only 8 ounces, what is the specific gravity of the wood?

Weight of the lead in water	12 *oz.*
Weight of the wood in ditto	8
Difference	4

It is evident that the lead was borne up by the wood, so as to weigh 4 ounces less, and therefore the wood was 4 ounces less heavy than an equal bulk of water; an equal bulk of water would therefore have weighed 20 ounces, and we may state

As 20 : 1000 :: 16 : 800.

The instrument used to find the specific gravity of *fluids* is called the *hydrometer*, which it is calculated to ascertain with the greatest precision. The hydrometer consists of a glass bulb, in the lower parts of which are many small shots of lead, and to this is affixed a tube of glass, on which the scale is marked. The stronger the spirit is, the farther the ball sinks in the fluid. There is no way of obtaining the strength of spirits so easy, expeditious, and precise, as by the use of the hydrometer, which renders this instrument of invaluable service to distillers, spirit dealers, and excisemen, in order to find the strength of liquors, and the duty which ought to be charged. The hydrometer will demonstrate the difference of bulks, and consequently the specific gravities in equal weights of spirits, *to the thirty*, forty, or fifty thousandth part of *the whole*, which is a degree of accuracy few *would wish* to exceed.

TABLE OF SPECIFIC GRAVITIES.

ed water	1,000	Diamond	3,521
ater	1,026	Rock crystal	2,650
um, purified		Agate	2,590
fused 19,500		Onyx	2,376
hammered 20,377		Muscovy talc	2,792
gold 19,258		Common slate.....	2,672
ard gold 17,486		Alabaster.....	2,730
ıry at—40° ...15,545		White marble	2,716
— at—47° ...13,545		Limestone, from	
ilver, cast....10,474		1,336 to	2,390
fused 11,352		Ponderous spar	4,474
th	9,823	Fluor spar	3, 80
l	8,660	Pumice stone.....	0,914
cast	8,396	Glass, from 2,520 to	3,437
.....	7,812	Dry ivory	1,825
r, fused	7,788	Sulphur	1,990
ısed	7,291	Phosphorus	1,714
ast	7,207	Ebony	1,117
bar	7,788	Yellow amber	1,078
.....	7,846	Spirits of wine	0,837
.....	7,191	Concentrated sul-	
nese	6,850	phuric acid.....	2,125
ony	6,702	Ditto nitrous ditto..	1,580
ten	6,678	Ditto muriatic ditto	1,194
um	6,115	Ditto fluoric ditto ..	1,500
denum	6,000	Oil of olives	0,915
c	5,763	Camphor	0,989
.....	4,300	Spermaceti	0,943
s	4,200	Yellow wax	0,965
an	3,700	White wax	0,869
la	3,000	Tallow	0,942
.....	2,660	Dry oak	0,925
sia	2,300	Ash	0,800
.....	2,300	Maple	0,755
ne	2,000	Elm	0,600
al ruby	4,283	Fir	0,550
.....	1,118	Cork	0,240
ld of Peru ..	3,775		

Metals *hammered* or drawn into wires have an increased specific gravity.

When the specific gravity of any substance is known, it is easy to calculate the weight of any given bulk of it, as the figures which denote the specific gravity also denote the number of ounces avoirdupois in a solid foot.

Example 1. What is the weight of 12 solid feet of lead?

11352 specific gravity
7

16)79464 ounces

28)4966 8

4)177 10 8

cwt. 44 1 10 8 answer.

Example 2. What is the weight of 48 solid feet of oak?

925 specific gravity
48

7400
3700

16)44400

28)2775

4)99 3

cwt. 24 3 3 answer

Obs. Proof spirit consists of half water and pure spirit: that is, such as when poured on gunpowder and set on fire, will burn all away, and afterwards ignite the powder; but if the spirit be not so highly rectified, there will still remain some water, which will make the powder wet and unfit to take fire. Proof spirit of any kind weighs 7 lbs. 12 oz. to the gallon.

HYDRAULICS.

Poor child of dust! do not aspire
To search the counsels dread and dark
Of Him, whose glory is far higher
Than human eye may ever mark;
Think not that this flesh-shackled mind,
Captive and pining here in pain,
Can pierce His secrets, or unbind
One link of nature's mystic chain;
For oh! the only cold reply,
To boasted reason's anxious call,
From earth, or air, or sea, or sky,
Is solemn gloom, and darkness all!

Yet do not deem this earth a maze,
Nor think thou art benighted here,
Call not each joy the wizard blaze
Of an infected atmosphere,
That like a fen fire would allure
Our spirits from fair virtue's ray,
And all that we think holy, pure—
Leading our trembling hearts astray.
Oh! do not still distrust each hour,
Though shadowed round by guilt and sin,
When an Eternal Godhead Power
Will give the bosom light within!

And many are the flowerets springing
Beneath that pure unfailing light,
That bud and bloom are ever bringing
To make our sullen way more bright—
Buds that are pregnant with a balm,
And blossoms tinctured by the skies,
To make the wounded spirit calm,
And the rude heart a paradise;

Where the High Holy One might walk
At the soft cool of morn or even,
And as in Eden's garden, talk
With spirits journeying to heaven.

The blithe young herald lark, though born
Even in a nest of lowly earth,
Soars 'mid the clear deep blue at morn,
To greet the bright sun's daily birth:
The gentle dove, though she has been
Stolen from her nest by those that roam,
When loosed, though climes may intervene,
Will spread her pinions towards home:—
Shall man then be without a guide,
To shew the goal 'tis his to win?
Oh no! for God will still preside,
To shed in love his light within!

A light to teach, a light to move,
And be the spirit's comforter;
A voice to question and reprove,
Whene'er the giddy soul may err.
Oh! brighter than the brightest gleam
Of sunshine in the brightest clime,
Comes down that everlasting beam
To hearts, when in their mid-day prime!
And softer than the gales of spring
Shed o'er the yellow heath in bloom,
Comes the delightful whispering
Of that all heavenly voice in gloom.

Then be not faithless, man! nor spurn
That inward radiance, struggling through
Thy spirit, like the stars that burn
At midnight, in the mist-veiled blue!
Quench not the hidden flame, that lies
All secret, but yet burning still,
Like the pure central fires that rise
Within some ice enveloped hill!
But yield to it, and it will throw
A glory o'er thee and such grace,
As born in love will almost shew
Thy God unto thee—face to face!

CHAPTER VI.

Motion of Water—Common Level.—Aqueducts.—Reservoirs. Velocity of Water—Ratio of Pressure.—Of the Syphon—of the Common Pump—of the Forcing Pump—the Steam Engine.

HYDRAULICS comprehend the laws which regulate fluids when in motion, and the various machinery employed in connection with their motions.

Water can only be set in motion by two causes, the increased pressure of the air, and by gravitation; this leads to the important fact in hydraulics, that all fluids which have a communication, will be perfectly level on the surface when at rest. Thus if two casks be united together by a pipe going from one to the other, and if water be poured in, it will rise to exactly the same level in both; if the pressure of the atmosphere be taken away, water will rise above its level, as in the case of the syphon and common pump.

In consequence of water always finding its own level, the most important effects arise, which add greatly to the comforts of civilized life. Water from a reservoir may be distributed in pipes over a town, and will rise to any height not exceeding the level of the surface of the water in the reservoir: hence it may be raised to the first or second floor above the street, or still higher. The reservoirs of the New River Company at Islington, and at the end of Tottenham Court Road, having the water at a higher elevation than many parts of London, can easily distribute it to various parts of the city. The

Grand Junction water company raise their water to the top of a high tower at Bayswater, by means of a steam engine, and are able to effect the same purpose. From the same principle water may be conveyed from one cistern into another in a dwelling house. The ancients, from their ignorance of this principle, built immense canals of stone, which conveyed, by means of arches over vallies from mountain to mountain, the water necessary to the wants of the inhabitants of their cities: the ruins of their aqueducts are the most magnificent remains of antiquity.

The velocity of water proceeding through a hole in the side of a vessel, is proportionate to the distance of the aperture from the level of the fluid, the square root of the intermediate space being the guide. In order to make double the quantity of a fluid run through one hole as through another of the same size, it will require four times the pressure of the other, and therefore the aperture must be four times the depth of the other below the surface of the water; and for the same reason, three times the quantity running in an equal time through the same sort of hole, must run with three times the velocity, which will require nine times the pressure, and consequently the hole must be nine times as deep below the surface of the fluid, &c.

Exp. Fill with water a cask in which you have made a hole, secured by a cork, in the lower part, and mark at the side by means of any scale or measure the height *of 1 inch, of* 4 inches, of 9 inches, of 16 inches, and of *25 inches.* Now take out the cork, and notice exactly *while the* water is running out how long it takes to sink

to 16 inches, it will require exactly the same time to sink from 16 to 9 inches, also exactly the same time to sink from 9 to 4 inches, the same time also to sink from 4 to 1 inch, and then the same space of time for the remaining water to run out.

The horizontal distance to which a fluid will spout from a horizontal aperture in any part of the side of an upright vessel, below the surface of the fluid, is equal to twice the length of the perpendicular to the side of the vessel, drawn from the mouth of the pipe to a semicircle described upon the altitude of the fluid; and therefore the spout will be to the greatest distance possible from a pipe whose mouth is at the centre of the semicircle; because a perpendicular to its diameter, supposed parallel to the side of the vessel drawn from that point, is the largest that can possibly be drawn from any part of the diameter to the circumference of the circle. The curve described by the spouting fluid will, in all the different situations, be that of a parabola, being acted upon by the combined forces of the lateral pressure of the fluid in the vessel, and the force of gravity.

Of the Syphon. The syphon is an instrument that acts by the pressure of the atmosphere being removed from the surface of a fluid, which enables it to rise above its common level. It is a very useful instrument, and is employed for the purpose of emptying liquors from casks.

Exp. Get a piece of small leaden pipe, which may be had for a few pence at the plumber's, and bend it in the shape of a note of interrogation (?). Now put the upper end into a vessel of water, and exhaust the air within by sucking at the lower end; when the mouth is with-

drawn the water will continue to run out, until it be so far exhausted as to admit the air into the upper end of the tube.

Were the syphon to consist of a tube 30 feet in height, the same effect would be produced. Syphons of this vast size are employed in the great reservoirs of some of our waterworks.

The syphon used for emptying casks is not put in action by exhausting the air between the mouth and the fluid, but is filled with liquor, and the short side is then put into the cask; by turning the cock this runs out, and the liquor in the cask being connected with it follows it, and may be taken off at pleasure.

Of the Common and Forcing Pump. The same cause which makes water rise in the syphon, makes it do so in the common pump. The common pump was invented by Ctesibius, a mathematician of Alexandria, about 120 years before Christ, although the principle falsely called suction was not known till about two centuries ago. The workmen of the Grand Duke of Tuscany wanted to raise water by a common pump to the height of 60 feet, but were not able to make it rise above 32 feet; the cause was then unknown, but further researches into the laws of nature discovered that the working of the pump produced a vacuum, and that the external air, by its pressure, would raise the water until a column of that fluid was equal in weight to a column of water. As the weight of the atmosphere is not the same at all times, the length *between* the lower valve and the water ought *not to* exceed 30 feet.

The mode of raising water by means of a pump is this: when the handle is raised the piston rod descends, and brings the piston valve (called the sucker or bucket) to another valve, which is fixed, and opens inwards upon the piston; when the handle is drawn down, the piston is raised, and as it is air tight, a vacuum is produced between the two valves; the air in the barrel of the pump, betwixt the lower valve and the water, then forces open the lower valve, and rushes through to fill up this vacuum, and the air in the pump being thereby less dense than the external atmosphere, the water is forced a short way up the barrel. When the piston again descends to the lower valve, the air between them is again forced out by forcing open the upper valve, and when the piston is raised a vacuum is again produced, and the air below the lower valve rushes up, and the water in consequence is again raised a little farther. This operation continues until the water rises above the lower valve; at every stroke afterwards the water passes through the valve of the descending piston, and is raised by it on its ascent, until it issues out at the spout.

The Forcing Pump. The forcing pump consists of two parts or barrels, one similar to the common pump, and the other rising by its side, and connected to it near the lower valve. The water is first raised in the former part in the same manner as in the common pump, excepting that the piston has no opening valve, and is solid, and the air is forced out through a valve into the other barrel; through this tube the water is also forced, and the pressure of the descending piston makes it rise and issue out at the top of the second barrel. The length of this barrel may be increased at pleasure, provided a sufficient power be employed to force the water up.

The common *fire* engine is an example of the *forcing pump in* operation, and the water works

formerly at London Bridge were a number of forcing pumps, set in motion by the stream of the river.

Of the Steam Engine. The most effective of all moving powers in machinery is steam, and it has the advantage that it may be employed in any situation; it now serves as the first mover in all kinds of mill-work; in planing, sawing, boring, conducting ships by sea; and coaches on rail roads, and recently on common roads by land.

The first idea of a steam engine is said by the English to be ascribed to the Marquis of Worcester, by the French to Papin; there is however good reason to believe that Brancas, an Italian, applied the force of steam ejected from a large ælopile, as an impelling power for a stamping engine, so early as 1629. The hint given in the Marquis of Worcester's Century of Inventions was carried into effect by Captain Savary, and has been from time to time improved by Newcomen, Cawley, and others, and lastly by Watt.

The steam engine consists of a large cylinder or barrel, in which is fitted a solid piston, like that of the forcing pump; steam is then supplied from a large boiler, which, in forcing up the piston, instantly opens a valve, through which cold water rushes, on the principle of the common pump; other steam is then introduced, which forces it down again and drives the water out of the pipe with immense force: the steam *then raises* the piston again, and again makes it *fall, by which* alternate motion the grandest

operations are performed. The action of the piston moves up and down a large beam, and this beam communicates to other machinery the power of one or two hundred horses.[1]

The power of some of the steam engines constructed by Messrs. Boulton and Watt, is thus described, as taken by actual experiment :— An engine having a cylinder of 31 inches in diameter, and making 17 double strokes per minute, performs the work of 40 horses, working night and day, for which three relays, or 120 horses, must be kept, and burns 11,000 lbs. of Staffordshire coals per day; a cylinder of 19 inches, making 25 strokes of four feet each per minute, performs the work of 12 horses constantly labouring, and burns 3700 lbs. of coals per day. These engines will raise more than 20,000 cubic feet of water 24 feet high, for every hundred weight of good pit coals consumed by them.

Several attempts have recently been made to introduce steam coaches upon common roads, but as yet, 1832, they have not been quite successful. It is however confidently calculated, that all difficulties in the way of making them common vehicles of conveyance will, at no distant period, be removed, which will perhaps benefit the country, and add to its already extraordinary resources in no common degree.

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[1] Watt's steam engine is upon this general construction, but has many improvements, which cannot be detailed without a reference to the engine in operation.

OPTICS.

LET THERE BE LIGHT!—God said—and light became
A type of truth; and—what is truth? has been
The cry from that sad hour, when Babel rose
Presumptuous to the stars, even to the time
The Governor did question Truth himself,
Yet waited not for answer. What is truth?
Millions upon millions still have asked
From age to age—and bigot creed on creed,
And pomp and ceremony, and show and form,
Have risen in replication. Here is truth!
Cried out the necromantic minds, that ruled
Amid the gaunt and giant pyramids;
When, in defiance of eternity,
Their spiky tops first pierced the clouds of heaven;
And from their shadows darkening the broad Nile,
Arose to shackle men, dread Osiris!
Like a magician with a hell-smoke bound,
Or solemn Isis, the dark ancient one,
Whose midnight veil of mystery no hand
E'er raised; and she stalked on through time,
In her thick panoply of darkness, armed
Against the piercing looks of the roused mind,
Chilling all bosoms with her horrid air
And undiscovered features. Here is truth!
Cried out aloud ten thousand oracles
From Babylon, and Tyre, and Nineveh,
Thebes and Ephesus, Athens and Rome,
And with the bleeding entrails of slain beasts
Twined round their arms, augurs and arch-flamen,
The Pythia and Haruspex enslaved
By darksome sayings, and dread words, the minds
Of kings, and ruled the destines of men
And empires—while the Thunderer, dread JOVE,
Went eagle-like before mailed hosts, and wax

Became an attribute of God! and strife
And massacre, an appetite and love
In man, and murder was a virtue!—Pomp,
And power and glory, sacerdotal pride,
The damning passions all let loose, like fiends,
Ran ravenous through the maniac earth, and brought
Old chaos back again upon the heart;
And rank confusion, tumult, havoc, death,
Reigned on through the mind's darkness.

LET THERE BE LIGHT!
God said again—and there was *Light*, and TRUTH [1]
Came o'er the gloom of the chaotic breast,
Like Him that bore the bow, and went forth proud,
Both conquering and to conquer. As he came
Onwards, in all the blazoned pomp of might
A king might own, and took the forked fires
Of lightning for his arrows, there arose
The spirits of the righteous dead, who felt
An influence struggling through their earthly powers,
From youth to age a warning light, a flame,
That purged the dross and calx of nature to
Perfection, and to holiness indeed!
From the corruption of the grave they rose,
To see the mighty Conqueror go forth
Unto all flesh—swift as the deadly bolt,
That takes the lightning for its pinion, He
Plunged forth upon his pure and milk-white steed—
Stern righteousness! yet went not forth to tread
Down the high pride of kingdoms, or to crush
The might of empires, or to lay the stone
Of desolation in the heart of cities—
But in the heart of man—to light the brand
Of devastation in its citadel,
And bring its fortress to the ground! and thus
He came among the throngs of earth; his eyes,
As he passed on through millions chained and bound
By sin, fell like a bale fire on their fetters,
And they were dust! while his sharp arrows glanced
Thicker than hail, to slay the murderous passions,

[1] *Revelation*, ch. vi.

That hold their dreadful carnivals amid
The wrath of the full bosom, and the darkness
Of the benighted mind! Pride was struck down,
Like a remorseless tyrant on his throne,
Smote by a patriot's arm! Fiery revenge,
Stirring her boiling cauldron of thick blood,
And quaffing it from human sculls, shrunk back
Aghast and pale! He had a withering look
For Malice, muttering her deep curses, shut
In caverned secresy, where scowling through
The gloom of her dark thoughts, like a foul witch,
Bearing the mark of Satan, mumbling spells
And dreadful incantations, and deep charms,
She sat through the long night, to fashion spells
For innocence! He had a withering look
For Envy, vomiting her poisonous slime
On beauty's tomb, or pouring cancerous breath
On virtue, smiling through youth's golden prime,
Like sunlight through the dew-showers of the spring,
As breathes a venomous reptile o'er a flower,
Giving back poison for its sweets. And thus
He passed through all triumphantly, his steed
Drinking at times of man's fermenting gall;
While his mailed hoofs struck fire from flinty hearts,
Smote to the dust! The carcasses of those,
That marshalled against heaven stern phalanxes
Of blasphemy and crime, were thickly spread
Around him as he rode! Anger's dark scowl—
Scorn's snaky lip—Lust's burning glance—and Hate's—
Undying Hate's cold marble forehead, carved
Into immortal wrinkles, paved his way
Of victory! Heaven shouted as he past,
And earth did shudder, but yet welcomed him!
Thus he went forth, both conquering and to conquer,
Became at once the Way, the Truth, the Life—
His bow for ever bent! eternal strife,
With passion, and iniquity, and sin,
Still flaming on his brow—annihilation
To evil raging in the minds of men,
Still burning in his glance! ———————

CHAPTER VII.

Definition and nature of Light—its velocity and minuteness—possessed of weight—course of Light.—Of the refraction and reflection of Light.—Of plane, concave, and convex Mirrors. Burning Mirrors.—Of Lenses.—Of the Camera Obscura—the Magic Lantern—Phantasmagoria, &c.

OPTICS is the science of vision, and treats of light and colours, the phenomena of visible objects, and of the instruments used in the study of the science. It is divided into three parts —1, *Catoptrics;* 2, *Dioptrics;* 3, *Perspective.* The first explains the properties of reflected light, the second considers the refraction of light while passing through different media, and the third relates to drawing, and the representation of objects on a plain surface.

Light consists of inconceivably small particles, emitted from a variety of bodies called luminous. The sun is the chief fountain of light, and is continually sending it off to illuminate our system. The particles of light are extremely minute; if this were not the case, the rays of the sun would be most destructive, from the immense velocity with which they are projected. By the observation of the eclipses of Jupiter's satellites, it has been found that light comes to our earth from the sun, a distance of 96,000,000 miles, in about 8 minutes, which is about 200,000 miles in a second — i. e. it travels as much as eight times round the globe while the pendulum makes one vibration. The smallest sand we can possibly perceive, moving at this rate would

penetrate our bodies and destroy us, yet light does no injury even to our delicately constructed organs of vision. The minuteness of the particles of light may also be inferred from their readily passing through glass, precious stones, and other transparent bodies.

Notwithstanding the extreme minuteness of the particles of light, there is reason to believe them to be possessed of gravity; indeed, being material, they could not be otherwise. From the experiments which have been made by the late Mr. Mitchell, the effect of their weight, though infinitely small, has yet been rendered apparent.

The rays of light move in straight lines, hence it follows that their intensity is diminished in proportion to the square of the distance: at 2 feet from a candle a person has only one 4th. part of the light he would have at 1 foot; at 3 feet distance, the 9th. part; at 4 feet, the 16th.; at 5 feet, the 25th. part; and so on.

On the Refraction of Light. Light naturally proceeds in straight lines, but as it is subject to attraction as well as other bodies, it may be drawn or bent from its course upon passing through one medium and entering another of a different density, as out of air into water or glass, or out of water or glass into air; when this takes place it is said to be refracted.

Exp. If the end of a stick be put into water, it appears bent, in consequence of the refraction.

To prove that light is refracted when passing from air *into water*, place a basin on the table, and observe where *the shadow* of the side of the basin, formed by the light

of a candle, falls within it; lay a halfpenny down there, to mark the exact place, and pour water into the basin, and the shadow will then fall much nearer to the side than before.

That light is refracted when it passes out of a denser into a rarer medium, is thus proved:

Exp. Place a basin on the floor, and put a shilling into it, and let the eye be placed at some fixed object, as at the back of a chair, so as just to see the edge of the shilling; if water be poured into the basin, the shilling will be seen most distinctly. When no water was in the basin, the rays of light from the shilling went in such a direction as not to make it visible to the eye, but when water was poured in, they suffered a refraction when they emerged from it, and proceeded to the eye.

Another easy experiment is to put a shilling in a wine glass, and pour on a little water, there will appear two shillings in the glass; for an image of the shilling will come directly to the eye, also the rays of light rising through the water, will then be refracted and come to the eye, and present another image, higher up than the other.

The light of the sun passing through empty space, until it arrives at an atmosphere of a certain density near our earth, is then refracted, or bent down towards the earth; it is for this reason that we have the twilight before sunrise and after sunset; this also makes a difference between the true and apparent rising of the sun, planets, &c. At the vernal or autumnal equinox, the sun ought to rise and set exactly at 6, yet if a person at the sea side observe the time of the sun appearing above the surface of the water, or sinking below it, it will be found to be 7 or 8 minutes before and after 6. In making astronomical observations therefore, allowance

must always be made for the refraction produced in this manner, in stating the height above the horizon of any heavenly body; the allowance must be greater or less according to circumstances, and a precise and certain rule for ascertaining it is still a desideratum in astronomy.

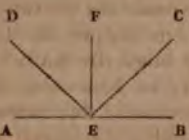
The degree of refraction is greatly increased by a humid state of the atmosphere; land at great distances, that cannot be seen in the clearest weather, may sometimes be suddenly brought into view, but then great and continued rains invariably set in.

In high northern latitudes the refraction is very great, the atmosphere being condensed by cold. The Dutch sailors who were shipwrecked in Nova Zembla in 1596, and spent the winter there, were agreeably surprised to see the sun return to them several days sooner, than from the latitude they had a right to expect him.

It is from the refraction of light that we are enabled to assist enfeebled sight, and to add to the powers of sight in general, by the use of lenses and optical instruments.

Of the Reflection of Light. As when the rays of light are bent out of their straight course they are said to be *refracted*, so when they strike against a surface they are sent back again from it, and are then said to be *reflected*.

When a ray of light falls upon any body, it is reflected, and the law which rays of light uniformly observe in their reflection is, that the *angle of incidence* is always equal to the angle *of reflection*; upon this fundamental principle all *the properties* of mirrors depend.



Example. Let a AB be a reflecting surface, and CD a ray of light falling upon it at E, and let FE be a perpendicular line. The angle CEF is called the angle of incidence. The ray of light will be reflected in the direction ED, so that the angle of reflection FED, will be equal to the angle of incidence CEF.

This rule is easily exemplified: — I stand directly before a looking-glass, and my image is reflected back to me; if I stand a little on one side, I cannot see myself, but another person, who stands just as far off on the other side of it, can see my image in the glass, and I his. If I place a candle a little on one side, I must go exactly so far on the other to see its image in the glass.

This is the same rule which takes place in the collision of elastic bodies against any surface. If a marble is thrown against the wainscot in a right line, it returns by such; if it is thrown against it sideways, it goes off at the same angle with which it came to the wainscot.

Light falling upon transparent bodies is partly reflected, only a portion of the rays passing through them: thus a person standing near the glass of a window will see his image in it indistinctly. When parallel rays fall on a concave *mirror which* is not transparent, they will be *reflected back*, and meet in a point, at half the

stance of the surface of the mirror from the
entre of its concavity, for they will be reflected
t as great an angle from the perpendicular to
he surface of the mirror, as they fell upon it
with regard to that perpendicular, but on the
opposite side thereof.

The rays which proceed from any *celestial*
object may be esteemed parallel at the earth,
and will meet at the same point from the mirror
when turned directly towards the object. The
rays which proceed from any remote terrestrial
object are nearly parallel at the mirror, but not
strictly so; they come *diverging* to it in separate
pencils, or rays from each point of the side of
the object next the mirror, therefore they will be
converged to a point at the distance of half the
radius of the mirror's concavity from its reflecting
surface, but at separate points, at a distance a
little greater from the mirror, and the nearer the
object is to the mirror, the further these points
will be from it, and an inverted image of the
object will be formed which will seem to hang
pendant in the air, and will be seen by an eye
placed beyond it, (with regard to the mirror,) i
all respects like the object, and as distinct
the object itself. If the radius of the mirror
concavity and the distance of the object from
be known, the distance of the image is fou
by dividing the product of the distance
radius by double the distance made less by
radius, and the quotient is the distance requi
If the object be in the centre of the mirr
concavity, the image and object will be co
dent and equal in bulk.

If a pencil of parallel rays be incident on a *convex* spherical speculum, they will be reflected diverging, and the focus of the reflecting rays will be at the radius which is parallel to the incidental rays, and be virtual. If a radiant object be placed before a convex speculum, the image will appear behind the speculum; it will appear correct, and will be less than the object. As the object approaches the speculum, the image will likewise approach to meet it, and increase, till at length, when the object touches the speculum, the image will appear to touch it likewise, the image being convex towards the object.

Convex mirrors diminish objects seen in them; a globe of glass silvered in the inside, exhibits a panoramic view of surrounding objects, but they will appear of different sizes, according to their proximity or remoteness with the mirror.

Concave mirrors make objects appear larger, but distorted: with one of them some curious experiments may be performed.

Exp. Let a concave mirror be fixed on a wall or chair, and a person beyond the focus will see his image inverted; as he puts forth his hand, the image will do the same; as he tries to clasp the hand, it vanishes from the view. Let a person hold before a concave mirror a bottle half filled with water, the image of the bottle will be seen inverted, but the mind will conceive the water to be in that part which appears to be lower. Let the mouth of the bottle be held downwards, and take out the cork; as the water runs out, the illusion of the mind will be such, that the bottle will seem to fill until all the water be gone, when the illusion vanishes.

A concave mirror throws back the sun's rays *into a point* or focus, where paper, gunpowder,

&c. may be set on fire. The degree of heat generated in the foci of different speculums when exposed to the sun's rays, are as their areas directly, and inversely as the squares of their focal lengths; and the heat generated in the focus of a speculum employed as a burning glass, is to the sun's direct heat, as the area of the speculum to the area of the image.

Ancient historians speak of wonders done by Archimedes, in burning at a great distance the Roman ships besieging Syracuse. In order to ascertain what degree of truth there was in these accounts, Buffon performed many experiments; with 40 glass specula he kindled deal boards at 66 feet distance, and with 128 specula he did this at 150 feet distance; with 45 he melted tin at 20 feet distance, and with 117 he melted silver; at another time employing 168 mirrors he kindled wood at 200 feet distance, melted tin at 150, lead at 130, and silver at 60 feet distance.

As to the *reflection* of light we are indebted for burning mirrors, so to the refraction of it we are indebted for what is of infinitely more value in common life, the uses of lenses or artificial glasses, to aid the powers of sight.

A lens is usually made of glass, but may be made of any transparent substance, as ice, crystal, &c.; the surfaces are polished and spherical, or spherical on one side and flat on the other. When this is the case they are called plano-convex; when spherical on both sides, a *double convex*; when flat on one side and concave on the other, plano-concave; when concave

on both sides, a double concave: a meniscus is convex on one side and concave on the other.

A convex lens collects the rays of light into a focus, which is easily shewn by a burning glass or a common pair of spectacles, by which paper or gunpowder may be easily ignited. A voyager towards the North Pole made an immense burning glass by grinding a piece of ice into a convex lens, which set fire to wood at a considerable distance. Plutarch informs us, that when the vestal virgins let the sacred fire go out, they were obliged to light it by means of the sun's rays collected through burning glasses. Pliny speaks of burning glasses, but in an incorrect manner, lib. 36, c. 26. Lactantius (De Ira Dei) informs us the ancients employed a glass globe, filled with water, for condensing the sun's rays to make a fire.

When the sun's rays are made to converge by a plano-convex lens, the distance of the focus from the glass is equal to the diameter of the sphere of which the lens is part; when a double convex lens is employed, the distance of the focus is only half the diameter or radius.

Every lens, whether convex or plano-convex, may be made to collect by refraction into one point the rays of the sun dispersed over its surface, and thus become a burning lens; the rays thus concentrated are so much the more as the surface of the lens exceeds that of the focus. The most considerable of these glasses was made by Mr. Porter, of Fleet Street, and was formed of flint glass, nearly 3 feet in diameter, weighing 212lbs., the focal length was 16ft. 8in., diameter

of the focus 1 inch; a second lens was used, which collected the rays from this, and reduced the focus to half an inch. This instrument fired every kind of wood, melted iron, tin, gold, &c. in an instant; tiles, slates, and all kinds of earth and stones vitrified in a moment, while sulphur, pitch, and all resinous bodies melted under water. The substances most difficult to be wrought on were those of a white colour; though water alone was not affected, yet if a little ink were thrown in it speedily became hot.

The rays of a candle may be made to converge by a plano-convex lens; observe the image of the candle from light passing through a single or double convex lens, the image is inverted.

A bottle or phial of clear glass filled with water makes the rays of light converge to a line. Jewellers use a globe of glass filled with water, to draw the light of the candle or lamp to a focus, for the purpose of obtaining a pure and intense kind of light; and the poor lace makers of Buckinghamshire, on coming to their work, each brings a clear glass bottle filled with water, which is fixed into a rest round a single candle, which makes the light sufficient for the whole party, by obstructing it from its natural course into the room, and refracting it down upon their delicate work.

Take a convex lens and hold up near the window, and hold a sheet of white paper behind it, a picture will be seen upon the paper. This *picture would* be more distinct if the room were *darkened* as much as possible, and little or no

light admitted but what came through the lens. The camera obscura is an optical machine, made on this principle; it may be made to represent objects upon a paper laid flat, and is much used by artists; sometimes the light is let down from a hole in the top of a darkened chamber, and thrown upon a white table, when it gives the surrounding objects, with all the moving objects which it presents. It is this kind of camera obscura which is sometimes seen as a penny exhibition at fairs, &c.; and the same thing fixed on the top of a house which commands an extensive prospect, is highly amusing and interesting. There are several such at the watering places on the coast, &c.

The Magic Lantern and Phantasmagoria. This instrument is in construction very simple, being mearly a tin lantern, within which is a lamp, whose light passes through a plano-convex lens, placed in a tube fixed on the front. This strongly illuminates a small transparent painting on glass, placed before the lens in an inverted position; another tube containing a convex lens slides within the other, so as to adjust the focal distances of the glasses. The illumination is often increased by means of a convex mirror, placed at the back of the lamp; to render the picture distinct, no light should fall on it but what passes through the lens.

The phantasmagoria is the same as the magic lantern, with this difference, that in the common lantern the figure is painted on the glass, while all the rest of the glass is left transparent, con-

sequently the image of the figure on the screen has a circle of light round it; in the phantasmagoria the glass round the figure is blackened, so that no light passes to the screen but what passes through the figure itself; thus is seen upon the screen the figure without the circle of light, which heightens the illusion. Instead also of the representation being made upon a wall or sheet, it is thrown upon a thin screen of silk placed between the lantern and the spectator; from this the image may be made to recede or advance, as the lantern is removed further from or nearer to the screen; for the size of the image must increase as the lantern is carried back, because the rays come in the form of a cone. As no part of the screen can be seen, the image will appear to be formed in the air, and to move further off as it becomes smaller, and to come nearer as it increases in size, although in reality it is still at the same distance. During last winter a woman was frightened in such a manner that she died from the effects of it, by one of these instruments exhibited at one of the theatres, under the name of optical illusions.

OPTICS.

(Continued.)

Token of mercy! Token of love!
That smilest when the heavens seem to weep
And from the stern storm-cloud above
First threw a soft bloom o'er the deep,
When the deluge was past, and the thunders were dying,
And the dove, with her green olive peace branch was flying.

Oh! beautiful arch of the sky!
Like thee lovely Hope still appears,
Given out by some light from on high,
To throw smiles in the midst of our tears,
And with beauty, and splendour, and glory illume
The depths of our sorrow and clouds of our gloom.

When the cloud covered aspect of heaven,
Is more gloomy, and sullen, and drear,
A double display then is given
Of thy image more lucidly clear;
Like faith to the Christian's heaven-gazing eye,
Increasing in brightness as perils draw nigh.

Thy colours so beautifully blending,
A type of that faith seems to be,
Which, although diverse, is still ending
In one bond of love, Lord, from Thee;
And like thy proud pillars, seems formed to embrace
In harmonious concord the whole human race.

Then, oh! Glory and Light of the storm!
Whene'er on thy beauty we gaze,
May some token be given to warm
Our bosoms to rapturous praise;
Unto Him whose Good Spirit in mercy doth rest,
Throwing beauty and light on the tempest-smote breast.

CHAPTER VIII.

The Rainbow, Lunar and Solar. — Decomposition of Light. — Of the Telescope.—Of the Microscope —Of the Eye and its Organization.—The Mechanism of Vision, &c.

One of the most beautiful things in nature *connected* with the refraction and reflection of

light is the rainbow. This phenomenon attracted the attention of the philosophers of all ages; it was, however, reserved for Sir Isaac Newton to explain its cause. The rainbow is formed by the solar rays entering drops of falling rain, and being there refracted on the further surface, emerging from the drops after one or more reflections, and at their emergence, as well as at their entrance, suffering a refraction by which the compound rays are separated, they enter the eye of a spectator, and exhibit the prismatic colours, the eye being then in the vertex of a cone, in the surface of which all the drops lie, which render the rays of any one colour efficacious; hence it is that the bow appears circular. The axis of the cone is directed to the sun, and hence the sun is directly opposite to the centre of the bow. The primary bow is that most usually seen in the heavens, and is formed of two refractions, and one intervening reflection of the rays; the secondary bow is formed by the rays emerging, after two refractions and two intervening reflections. Hence in the primary bow the *least* refrangible rays, and in the secondary bow the *most* refrangible rays are outermost. The colours appear so much the more vivid as the cloud behind is darker, and the drops of rain fall thick or fast. The drops falling continually, produce a new rainbow every moment, and as each spectator has his particular situation from which he observes the phenomenon, it so happens that no two persons, *properly* speakiug, can see the same rainbow. *A lunar* rainbow is the same phenomenon by *moonlight*, and attributable to precisely a similar

cause; the colours of the lunar rainbow, which is very rarely seen, being much fainter than that of the solar one.

Light was long thought to be a simple substance, but it has been decomposed by Sir Isaac Newton, and found to consist of seven kind of rays combined. The rays reflected from opaque bodies always bring with them to the eye the idea of colour, but this colour is nothing more in the bodies than a disposition to reflect to the eye one sort of rays more copiously than the others; for particular rays are generally endowed with particular colours. Newton made the rays of the sun to pass through a prism, a long three-sided piece of glass, and from their different degrees of refraction the primary rays were separated into the same as those seen in the rainbow. All kinds of pieces of uneven cut glass will more or less shew the refrangibility of light, and the colours of the rainbow are often very beautifully exhibited by the sun's rays passing through the knot in the centre of a pane of glass, such as is usually put in out-houses &c. for cheapness.

When the primary colours are separated, the proportions they occupy are as follows :—Light being supposed to have 360 parts—violet occupies 80; blue, 60; green, 60; yellow, 48; red, 45; indigo, 40; orange, 27. White is a compound of all these: to prove this—

Get a circular piece of board, and paint it with the different colours in the above given relative proportions, put it on an axle, and make it rapidly revolve, and its whole surface will appear white. When an object *appears black*, light is completely absorbed, and the

cause of whiteness in bodies is but a disposition to reflect all colours of light nearly in the proportion in which they are mixed in the original rays.

Light cannot be divided further than into these colours; if a second prism be made to receive any of the divided rays, it has no further effect. If the divided rays of light be brought together by a burning glass to a focus, the colour is white.

Of Telescopes.—Telescopes are divided into two kinds, the reflecting and the refracting; in the former concave mirrors are used, which reflect the appearance of the object to the eye of the beholder, and the latter are composed of convex lenses, through which the images of the objects are seen refracted, or bent towards the eye of the observer.

The reflecting telescope, which was invented by Sir Isaac Newton, and improved by Dr. Gregory, is generally preferred for astronomical purposes, because the principles of its construction admit of its being made to magnify more than a refracting telescope of the same length. The refracting telescope is better for common and frequent use, being of more simple construction; those which have their glasses so contrived as to correct the unequal refraction of the sun's light, are called acromatic telescopes.

Telescopes in general represent terrestrial objects to be nearer, but not larger, and this is the magnifying power of the telescope. Thus, looking at a man at a hundred yards distance with a telescope that magnifies 100 times, the man will appear to be no bigger, but will be *seen* as distinctly as if only one yard off; and *the like* of other objects situated on the earth.

Of Microscopes. By a microscope we understand an instrument for viewing small objects; there are many kinds of microscopes, but only three kinds are distinct in principle, namely, the single, the compound, and solar microscopes. The single microscope consists of one lens only; a drop of water, or a small globule of glass, is a microscope of this kind; and Dr. Hook says, that with a microscope made by melting a piece of glass into a small drop, he was able to distinguish the particles of bodies, of which a million of millions would not make up the bulk of the smallest visible grain of sand. The compound microscope consists of two convex lenses, an object glass, and an eye glass; these kind of microscopes have usually two eye glasses, which give a much larger field of view, and likewise increase their magnifying power. The solar microscope is composed of a tube, a convex lens, and a common microscope, and acts by throwing the shadow of the figure to be examined upon a large screen, and this image may be magnified almost to any size.

It has already been seen, that rays of light passing through convex lenses converge, and if thrown on white paper will exhibit a picture of the objects from whence they proceeded; what is done artificially by glasses on paper, is done naturally by the humours of the eye.

The eye by its organization perfectly resembles an optical instrument, being actually similar to a telescope,—1st. an exterior envelope, which forms the frame work, the interior of which, *perfectly black,* has a perfect resemblance to a

camera obscura; 2nd. refrangent bodies, calculated to re-unite the luminous rays into given foci; 3rd. a membrane perforated in the centre, for the purpose of rectifying the aberration of sphericity; and lastly, of a nervous organ, on which the luminous foci which develope the impression meet.

The external coat or membrane of the eye is called *sclerotica;* it is strong, elastic, and of a white colour, resembling parchment; the hinder part is very thick and opaque, but it grows gradually thinner, till at that circular part where we observe the iris it becomes perfectly transparent, and is like a convex lens—this part is called the *cornea.*

Immediately adherent to the sclerotica within, is the *choroides,* which is a soft and tender coat, composed of numerous vessels; it is inwards of a russet brown colour, punctured behind for the admission of the optic nerve, and its posterior surface is, to render its opacity quite perfect, covered with a black mucus, called the *pigmentum nigrum;* and distinguished into two parts, the fore part is called the iris, while the hinder part retains the name of choroides.

The *iris* is composed of two kinds of muscular fibres, one sort tending like radii toward the centre of the circle, and the other forming a number of concentric circles round the same centre. The central part of the iris is perforated, and the orifice, which is called the pupil, is varied in magnitude by the action of the two sets of fibres, or rather muscles, composing the iris. *When* a very luminous object is viewed, the

circular fibres *contract*, and diminish the orifice; and on the other hand, when the objects are dark and obscure, the radial fibres *contract*, and enlarge the pupil, so as to admit a greater quantity of light.

The third and last member of the eye is called the *retina*. This is a fine and delicate membrane, being an expansion of the medullary part of the optic nerve; it is spread like a net all over the concave surface of the choroides, and terminates at the ciliary ligament; it serves to receive the images of objects produced by the refraction of the different humours of the eye, and these images are painted, as it were, upon its surface; it is itself transparent, but appears black, by reason of the pigmentum nigrum spread underneath. The retina, as before said, being an expansion of the optic nerve, conveys the impression or sensation thus made upon it immediately to the brain.

The coats of the eye, which lay over each other like the coats of an onion, enclose three transparent bodies, called the aqueous, crystalline, and vitreous humours.

The *aqueous humour* is like water, and fills up the space between the cornea and ciliary ligament, being divided into two portions by the iris, which swims in it; these are called the anterior and posterior portions of the aqueous humour.

The *crystalline humour* is as transparent as the purest crystal, in consistence like a hard jelly, growing somewhat softer from the middle towards the edges; its form is that of a double

convex lens, but more convex on the interior than on the exterior surface: this humour is contained in a very strong and transparent membrane, called the arachnoides, and is suspended behind the aqueous humour by the ligmentum ciliare.

The vitreous is not so hard as the crystalline, nor so liquid as the aqueous humour; it fills all the interior chambers of the eye behind the crystalline humour.

Mechanism of Vision. The luminous rays emanating or reflected from a luminous body, form a cone, the base of which falls on the cornea; this membrane, being polished, reflects back a few of these rays, and the remainder, after having undergone divers refractions, penetrate into the eye to give the impression to the nervous organ. The fasciculus, which occupies the centre of the cone, is parallel with the axis of the eye; it falls perpendicularly upon the summit of the refrangent bodies, and reaches the retina without undergoing any refraction; but with respect to the rays of the circumference of the cone, they act as follows:—First, by crossing the cornea they are brought nearer to their own axis, and for this reason increase in intensity; 2nd. in entering the aqueous humour, where the power of refraction is something less than in the cornea, they slightly diverge from the perpendicular, in consequence of which some fall upon the anterior part of the iris, which reflects them in part, and whence are produced the variegated colours of this membrane; 3rd. the rays that cross the pupil are those only

which serve for vision; they pass backward, and strike upon the anterior face of the crystalline lens, some of them, in consequence of the polish of this body, are returned, others are absorbed by the black substance of the iris and of the ciliary processes, but the greater number of rays crossing the lens are powerfully refracted, and in consequence their intensity is considerably increased; 4th. the fasciculi having thus converged across the vitreous body, which continuing the effect of the refraction of the lens, and even increasing the convergency of the rays, they ultimately re-unite round their axis upon the retina, at a point called the focus. By the retina the sensation is developed; the portions of light that cross it are absorbed by the choroid: thus in passing through the eye the luminous rays form another cone, the base of which corresponds with the cornea, and the summit with a point of the retina: thus the eye is, in action, a delicately constructed camera obscura, for the rays of light flowing from all points of an object through the pupil of the eye, do, by the refraction of its humours, paint the image of the object in the bottom of the eye; so also is it that in the camera obscura, where all the rays, refracted from an object by a lens in the window shutter, paint the image of it on the opposite wall. The structure of the eye is so mechanical, philosophic, and beautiful, that were there no other part of the human frame to be observed, this would of itself loudly proclaim an All-wise and All-powerful Creator.

ACOUSTICS.

Oh, ETERNAL! hear our prayer,
For we are passing swift away,
Like ECHO on the wayward air,
Or dew upon the leafy spray,
Exhaled amid the sunny ray,
That in the mid-day is not found:
We are but dust—we are but clay—
A breath, a vapour, and a SOUND,
Heard for a moment brief, then lost to all around!

Oh, INFINITE!—for we are nought!
A fragile flower, a broken reed—
Life's mockery—time's cruel sport!
The worm waits in the brain to breed,
The viper on the heart to feed.
Oh, less than nought! a speck! a stain
On nature's page! a noisome weed!
And all we hold is false and vain,
Save our birthright of woe, and heritage of pain!

Oh, MOST MIGHTY! we are weak—
A brittle vase—a shattered urn!
Corruption lingers now, to wreak
Her vengeance on us, and to turn
The heart that fain in prayer would burn
To ashes!—then, Most Mighty! waken
Hope in this sinking breast, and have
Mercy when it is all forsaken,
Like some o'erthrown and ruined cave,
Foul with the taint of sin, and darksome as the grave.

Oh, OMNISCIENT!—for all dark,
And deadly dim and drear we feel;
And what, to this poor prisoned spark
Called soul, can idle life reveal?
Or what can paltry time unseal?

Do we not grope in blindness here?
Are we not lost when we would rise
Above this sublunary sphere?
And do not thy dread mysteries,
Like unto light's excess, deal blindness to the eyes?

MOST MERCIFUL—Most Gracious God!
To Thy dear love alone we flee,
And thou wilt not forsake this clod
Though dark and drear it still may be;
While it can fix a hope on Thee,
Thou art still bent to hear the prayer,
To cheer this darkness fill the breast
With buoyant faith, whose wings may bear
It on to peace, and joy, and rest,
And waft the fleeting spirit softly to the blessed!

CHAPTER IX.

Transmission of Sound.— Its Velocity.— Propagated through Water — by Rods. — Echoes. — Applied to Music, &c. — Mechanism of Hearing.

ACOUSTICS, also called PHONICS, is the doctrine or science of sounds; and sound, like light, is either refracted or reflected.

The manner in which sound is conveyed through the air is by circles, gradually enlarging in the manner of waves proceeding from a stone thrown into the water.

A string of a musical instrument when struck, produces a sound by its vibrations; stop these vibrations with the finger, and the sound ceases. An easy experiment will shew how glass is set in motion when it emits a sound.

Exp. Hold a tumbler sideways, and sprinkle a little dust or powder of any kind on it; then strike the glass and make it sound, the dust keeps dancing about whilst the sound continues. The noise from a gun is produced from a violent agitation of the air.

Sound has been found by experiment to travel at the rate of 1,142 feet in a second. If the wind blow from the sounding body to the hearer, the sound travels rather more quickly, and *vice versa*. All sound travels at the same rate: the report of a gun, and the striking of a hammer, are equally swift in their motions; and the softest whisper, (as is said of slander,) in proportion to the distance it goes, travels as rapidly as the loudest thunder.

Sound may be conveyed very far along the surface of water; during a calm the noise of cannon at sea may be heard a great distance. The firing of the guns in an action between the Dutch and English fleets was heard 70 miles off, on the coast of Suffolk. Dr. Clarke in his tour relates that he and his companions, when at a distance supposed to be 130 miles, heard all day long the sound produced by an attack of our troops on a fort near Rosetta.

The denser the air is, the louder is the sound; this has been proved by what happens when any noise is produced within the diving bell. As the air becomes more rare, or thinner, the sound is diminished. M. Saussure observed on the top of Mont Blanc, that a pistol fired off did not make a greater noise than a child's toy in a room. In the vacuum of an air pump sound is not heard.

Sound may be faintly propagated through water.

Exp. Take two stones, and putting your hands under *water*, strike them together, and a faint sound will be

communicated through the air. If a person hold his head below the water, and another cause a body to sound, the sensation will be felt: Dr. Franklin heard sound thus propagated at the distance of half a mile.

Sound may be conveyed very far along a rod of iron. In some experiments tried in Denmark, and afterwards in England, a sounding body was suspended from a wire of iron 600 yards long, and the sound was heard distinctly at the other end and almost instantaneously, when the wire was applied to the teeth or the ear. Through a tube of 215 yards, a person talking at one end was distinctly heard at the other: afterwards the experiment was tried with a tube 431 yards long, and the sound was still heard; at the distance of 1,000 yards, a man hallooing as loud as he could was barely heard.

Echo is produced by the air which has been set in motion striking against a wall, rock, &c. by which it is repelled; thus echo is a reflection of sound. "At two miles from Milan (says Addison) stands a building, that would have been a masterpiece of its kind, had the architect designed it for an artificial echo; we discharged a pistol, and had the sound returned to us above fifty-six times, though the air was very foggy. There are two parallel walls, which beat the sound back on each other till the undulation is completely worn out." The famous echo in Woodstock Park returns seventeen syllables in the day-time, when the wind is brisk, and twenty in the night, when the air, being denser through cold, the vibrations come slower.

and the repetitions of more syllables is heard. There is a much finer echo from the north side of Stepney Church, in Sussex, which in the night time will repeat these twenty-one syllables—

Os hominì sublime dedit cœlumque tueri
Jussit et erectos ———

Some buildings have a remarkable property in conveying sound; in buildings of an elliptical shape, a whisper in one focus will be distinctly heard in the other. The concert rooms in Edinburgh are so contrived, that the performers sit in one focus, and the musicians in the other: in the whispering gallery at St. Paul's, a person speaking in the lowest tone of voice is distinctly heard on the opposite side.

The principal use of this science is in relation to music, to which it gives a basis on the certain principles of the mathematics. Thus, if a musical string of any length, and a certain tension, produce a certain tone, half that length of the same tension will give the octave, two-thirds of it the fifth, and the other notes of the scale in exact proportion. The varying of the sizes of strings will produce similar effects; or if strings of the *same* size be extended by different weights, the tones will become more acute, in the ratio of the square roots of the weights.

All sonorous bodies which vibrate an equal quantity of times in a second yield the same sound: thus those which vibrate 256 times in a second, sound the note c in the middle of the musical scale; if the number of the vibrations *be half* the number of the above, or 128, the

note is an octave below the former; if the vibrations be double, or 512, the note will be an octave higher. A body which gives the gravest harmonic sound, vibrates 12½ times in one second, and the shrillest sounding body vibrates 51,100 times in a second.

Mechanism of Hearing. The external ear, owing to its funnel-like form, collects the sonorous undulations, and transmits them to the auditory canal; from hence they are conveyed to the membrana tympani, or drum, from its resemblance to that instrument, to which they communicate their vibrations. The tympanum being thin, dry, and elastic, like the skin of a drum, receives and transmits sounds to the internal ear in three different ways; namely, by a little chain of small bones, by the wall of the tympanum itself, which is dry; finally, by the air that fills that cavity. Other membranes, equally dry with that of the tympanum, partake of the oscillations, and transmit them to the internal ear or labyrinth, to a spot where a thin transparent humour is exhaled, called the water of Contunnius; in this humour the delicate filaments of the auditory nerve float, and the impression resulting from this contact by the agitation of the fluid, is ultimately transmitted through the acoustic nerve to the common sensorium.

CHEMISTRY.

When these corrupting particles are laid
Into the grave, and rank corruption feeds
Like a gross glutton, upon eyes and cheeks,
Lips that once shamed the coral, and the brow
Immaculate as marble,—oh, how dread
And terrible would be the thought, to die
Marr'd thus! and all the beauteous lineaments
Scattered and tossed, confounded, mixed, and crushed,
And lost in darkness! What despairing woe,
Misery and pain unutterable, and dark dread,
Usurps the mental kingdom of the soul
Endowed with no assurances from heaven—
Lineally descended from the throne
And focus of all truth! We have a charter,
Not drawn from nature's works, drawn from our God,
Death cannot cancel! Spirit there is made
Immortal—hath its liberty secured
On faith's eternal basis. Shall we then
Have fear for that dread hour, and shudder when
Nature gives tokens through the failing sense
How near we are to brittle life's dark close?
Unblenching we shall stand in that dread hour,
Looking all stedfast towards our heavenly home,
Like birds upon the wing to brighter climes.

Then let these atoms part, and be resolved
Through all the elements, be borne about
With winds, and made a portion of the tempest,
Or principle of the immortal thunders!
Let lightnings make dread havoc with their forms,
While change unceasing, multifarious,
And infinite, still rule them age by age—
Or fire, rain, vapour, snow, and hail, and storm,

The direful tumults and convulsive throes
Of wayward nature, claim them in their turns
For ministers of health or pestilence—
Let them appear in sickly fires, to mope
About in mists and exhalations foul,
Like the unquiet ghosts of murdered men
Through clammy vaults and church yards, in the fell
And haggard hour of midnight, making all
The stagnant air mephitical, and sowing
Death on the earliest breathings of the morn!
Still will the *soul* be stedfast, fixed, and calm,
Corruption is not hers—death cannot mar,
Annihilation cannot reach her!—God
Attracts her only; towards Him she flies;
For she is still a glorious particle
Of His pure essence; and resolved from dust,
Kindred *affinity* still works, and gives
Her back unto the source from whence she sprung.

CHAPTER X.

Elements of Bodies.— Classification. — Caloric. — Of the component parts of Atmospheric Air.—Of Oxygen and Nitrogen. —Of simple Combustibles—Sulphur, Phosphorus, Carbon, &c.

CHEMISTRY is that branch of philosophical science which investigates, and endeavours to ascertain, the ingredients of which bodies are composed, to examine the compounds formed by the combination of these ingredients, and to investigate the nature of the power which occasions these combinations. Chemistry has an intimate combination with all the arts of civilized life: in medicine it is of invaluable assistance, and there is scarcely a manufacture or trade, that does not depend either immediately or remotely upon a knowledge of this science; it also tends to enlarge the mind, and to give it, *when conducted* in a proper spirit, a more per-

fect knowledge of the laws which influence natural bodies, and consequently of the will of the Creator, affording us thereby some of the most refined pleasures and rational enjoyments.

Of the Elements of Bodies. Formerly earth, air, fire, and water, were supposed to be the elements of which all bodies were formed: chemistry however demonstrates that there are many different kinds of earth; that the air is composed of several kinds of fluids, called gases; and that water is composed of two distinct kinds of air united together. There are about 40 simple elements, which are divided as follows.

CLASS 1.
Comprehending the imponderable agents, or those that have no weight.
Heat, or Caloric; Light; Electricity.

CLASS 2. Oxygen.

CLASS 3.
Comprehending bodies capable of uniting with oxygen, and forming with it various compounds.

Division 1.
Hydrogen, forming water.

Division 2.
Bodies forming acids.
Nitrogen, forming nitric acid
Sulphur, ... sulphuric acid
Boracium, ... boracic acid
Carbon, ... carbonic acid.
Phosphorus, ... phosphoric acid
Fluorium, ... fluoric acid
Muriatium, ... moriatic acid

Division 3.
Metallic bodies, forming Alkalies.
Potassium, forming potash; and Sodium, forming soda.

Division 4.

Metallic bodies, forming earth.

Calcium, forming lime
Magnium, ... magnesia
Strontium, ... strontites
Jargonium, ... jargonia
Silicium, ... silex
Aluminum, ... alumine
Yttrium, ... yttria
Glucium, ... glucina
Zirconium, ... zirconia

Division 5.

Metals either naturally metallic, or yielding their oxygen to heat alone.

Subdivision 1.

Malleable metals.

Gold, Platina, Silver, Tin, Mercury, Copper, Iron, Lead, Nickel, Zinc.

Subdivision 2.

Brittle metals.

Arsenic, Bismuth, Antimony, Manganesium, Tellurium, Cobalt, Tungsten, Molybdenum, Titamium, Chromium, Uranium, Columbium, Iridium, Osmium, Rhodium.

Of Heat, or Caloric. Caloric in a latent state exists in all substances that we are acquainted with, though it combines with different substances in very different proportions. Heat considered as a sensation, in other words, sensible heat, is only the effect produced upon our organs by the *motion* of caloric, disengaged from the surrounding bodies. When we touch a warm body, a portion of its heat leaves it to pass to us; when we touch a cold body, a portion of our heat passes to it.

Caloric is generally considered under two heads—*free* or radiant caloric, and combined *caloric.* *Free* caloric is that which is not in any

way combined with any other body; and combined caloric is that which is fixed in bodies by affinity, or electrive attraction, so as to form part of the substance of the body.

Free caloric has the power of dilating bodies, and by forcing itself between their particles, causes them to occupy a greater space than before; an excess of caloric completely separates these substances, and they become burnt, fused, or melted. When uniting with a fluid, caloric, by forcing itself in abundance between its particles, completely destroys their attraction or cohesion, and they fly off in the form of vapour. Combined caloric is composed of specific and latent heat. By specific caloric we understand, the relative quantities of caloric that different bodies can contain, for different bodies, as has been recently ascertained, do not contain an equal quantity of caloric when heated to the same temperature.

Exp. Take a pound of lead, a pound of chalk, and a pound of milk, and having placed them in a hot oven, they will be gradually heated to the temperature of the oven, but the lead will acquire this temperature first, as having the greatest capacity for caloric, the chalk next, and the milk last. To ascertain that a less quantity of caloric enters into lead than into the other bodies to raise it to the same temperature, it will only be necessary to place these three bodies in equal quantities of water of the same degree of coldness, when it will be found that the water in which the lead has been immersed will be the least heated, that of the chalk next, and the milk most of all. We must not consider that this proceeds from the chalk and milk having greater bulk than the lead, as equal weight must always contain equal *quantities of* matter, though their dimensions may be *different.*

Latent caloric is that portion of insensible

caloric which is employed in changing the state of bodies, that is, in converting solids into liquids, and liquids into vapour. When a body changes from solid to liquid, or from liquid to vapour, its expansion occasions a sudden increase of capacity for heat, and it immediately absorbs a quantity of caloric, which re-appears and becomes sensible, when the body which it has transferred reverts to its former state.

Exp. Mix with snow muriate of soda, and it will be found by immersing the thermometer into the mixture, to be many degrees below the freezing point; expose this to the heat of the sun, and the thermometer will be observed to descend till all the ice is melted; when however all the ice is melted, the thermometer will begin to rise: the reason is, that the mixture absorbs the caloric without its temperature being raised.

As solids converted into fluids absorb latent heat, so fluids converted into solids give forth their caloric.

Exp. Take a solution of sulphat of soda, made very strong, and put it in a bottle hot, which cork immediately, observe that this will then not crystallize; when it is cold uncork the bottle, and it will be seen that on the admission of air the salt will suddenly crystallize, and give out its latent heat so that the bottle will be warm.

In general all bodies, whether solid or fluid, contract their dimensions, and become of more specific gravity, on cooling. This axiom has been long and strikingly acknowledged, but water forms a remarkable and striking exception to this rule. Water as it cools, instead of contracting and becoming heavier, becomes increased in bulk, and its specific gravity continues to lessen as it cools. The wisdom and goodness of the Great Architect will manifest itself in this arrangement, if we consider what

would have been the consequence had water been subject to this general law, and, like other fluids, become specifically heavier by the loss of its caloric: in winter, when the atmosphere became reduced to 32°, the water on the surface of our rivers would have become repositories of vast quantities of ice, which no subsequent summer could unbind, and the world would soon have been converted into a frozen chaos. How admirable the wisdom! how skilful the contrivance! that by subjecting water to a law *contrary* to what is observed by other fluids, the water, as it freezes, becomes specifically lighter, and swimming upon the surface, performs an important service, by preserving a vast body of caloric in the subjacent fluid from the effects of the surrounding cold, ready to receive its own accustomed quantity upon the first change of the atmosphere. The freezing of water therefore is a striking exception to this otherwise general law of nature, and is a memorable instance of the wisdom and providential care of the Almighty, when He established the laws of the universe.

Of the Component Parts of Atmospherical Air.

We have in Pneumatics detailed many of the properties of the air; we shall now make some observations on its component parts.

Atmospherical air is composed of about 22 parts of oxygen gas, and 78 of nitrogen gas.

Oxygen gas is a little heavier than atmospheric air, and 740 times lighter than water; combined with the atmosphere we breathe, it is the *principle of* combustion, the vehicle of heat, and is *indispensible* to animal life.

Nitrogen gas, or azote, is incapable of support-

ing combustion and animal life, is uninflammable, and somewhat lighter than atmospheric air.

Oxygen gas, if breathed separately, would cause a feeling of high spirits, sense of intoxication, great quickening of the pulse; in fact, we should find life burn out too rapidly. Nitrogen gas, though destructive to animals, is favourable to vegetables, and appears to be the substance which nature employs in converting vegetables to animal substances. Oxygen gas is continually thrown off from vegetables during the day into the atmosphere, while the lungs of animals, which in the act of respiration decompose the atmosphere, absorb the oxygen, and throw out nitrogen, thus keeping up a perpetual equilibrium, and preserving the salubrity of the atmosphere.

Exp. To shew the production of oxygen gas from the leaves of plants, fill a glass bell with water, introduce leaves under it, and place the bell inverted in a flat dish of water; expose the apparatus to the rays of the sun, and very pure oxygen gas will be disengaged, which will displace the water in the jar, and occupy its place. In like manner a sprig of mint, corked up with a small portion of carbon acid air, and placed in the light, renders it again capable of supporting life: the plant purifies what the animal had poisoned.

Another beautiful instance of Divine wisdom is, that nitrogen gas, being slightly lighter than oxygen, is, when thrown from the lungs in respiration, enabled during that short pause which it is ordained should take place between every respiration, to rise above the head. Had nitrogen gas been heavier instead of lighter than the atmosphere, the large quantities of it which are *thrown off* by men and animals would have

produced universal pestilence. How provident has the Almighty been, in thus foreseeing the operation of those laws which were designed to promote the welfare of every species of animated beings!

Besides these two gases, another gas, called hydrogen, is deserving of a few remarks. Hydrogen gas was formerly called inflammable air; its name now signifies, to produce water, 15 parts of hydrogen, and 85 parts of oxygen, being the component parts of water. We decompose water by pouring iron filings and nitric acid into the water to be decomposed, and the hydrogen gas rises up, and may be made to burn like a candle. To compose water of hydrogen and oxygen gas, M. Lavoisier made two tubes, one giving forth hydrogen gas, and the other oxygen, meet in the opposite sides of a large glass globe, previously exhausted of air: these two streams of gas being kindled by the electric spark at the point where they came in contact, the hydrogen combined with the oxygen, the caloric was set at liberty, and a quantity of *water* was the result, exactly equal in weight to that of the two gases introduced into the globe.

Nature abounds with hydrogen; and all kinds of vegetables, when assisted by the rays of the sun, have the power of decomposing water, as animals have of decomposing air, during which decomposition the hydrogen is absorbed, and goes to the formation of oil and resin in the vegetable, while the oxygen combines with part of the caloric received from the sun, and is given out in the form of oxygen gas; so that this one operation of nature gives nourishment

and provides materials of growth to the vegetable world, and at the same time renovates that vital principle in the atmosphere, which is necessary for the support of the animal creation. Surely nothing short of consummate wisdom could have conceived any thing half so beautiful in design, or extensively and superlatively useful in effect! (see pages 392 and 393.)

Besides these gases there are several others: carbonic acid gas, which was the first aeriform fluid different to common air that was known; this gas is found in large quantities in chalk, lime, &c. is fatal to animal life, and is much heavier than common air. We have nitrous gas; nitrous oxide, called the laughing gas, from the highly pleasurable and extraordinary sensation it produces on the animal system when inhaled; also sulphureous acid gas, ammoniacal gas, muriatic acid gas, oxygenated muriatic gas, fluoric acid gas, &c.

Of Simple Combustibles. Besides hydrogen, which is a simple combustible, we have other bodies so termed; these are sulphur, phosphorus, and carbon.

Sulphur, or *brimstone*, is well known, and is found in many parts of the world; it is very combustible and is the base of several compounds; and unites readily with oxygen, hydrogen, nitrogen, phosphorus, the alkalies, the metals, and with some of the earths. If sulphur be kept in fusion in atmospheric air, it absorbs a small quantity of oxygen, and forms oxide of sulphur; if it be heated sufficiently to take fire, it burns with a pale blue flame, and

becomes converted to *sulphurous* acid; but if sulphur be burned in pure oxygen, it absorbs the full dose, and *sulphuric acid* is the result.

Of Phosphorus. The real origin of phosphorus is very obscure; it is a peculiar substance, chiefly of animal origin; it is now generally procured from the decomposition of the phosphoric acid found in animal bones; it is never found in a pure or separate state; it is solid and very combustible, burns at a very low temperature, 100° degrees of Fahrenheit's thermometer, and absorbs in its combustion half as much again of oxygen as its own weight: when burnt in a receiver filled with oxygen gas, it gives forth a flame of the most vivid and intense brightness; surrounded by cotton rubbed in powdered resin, it takes fire spontaneously under the receiver of an air pump when exhausted, and displays a very beautiful phenomenon on the gradual admission of the air. It is used in making match bottles for instantaneous light, by mixing one part of flour of sulphur with eight of phosphorus. The light of the glow-worm is phosphorescent, and the extraordinary light seen upon the waves of the sea in warm latitudes, is produced from millions of animalculæ, possessed of a phosphoric nature.

Of Carbon. The base of common charcoal divested of all its impurities, is known to chemists by the name of *carbon*. It forms a considerable part of all organized bodies, or vegetables. Pure carbon is known only in the diamond, where it *subsists in* crystallization; cotton is composed *almost entirely* of it. It cannot be obtained *entirely* pure, as it will always contain some

hydrogen. The combination of carbon with which we are most familiar is charcoal, the coaly residuum of any vegetable that has been burnt in close vessels. Charcoal is a powerful antiseptic, has great affinity for oxygen, is unalterable and indestructible by age, or by air or moisture; it is not affected by the most intense heat. Putrid water, tainted meat, and an offensive breath, may be rendered sweet and wholesome by the use of charcoal; and for a dentrifice it is the best that can be procured, removing all scorbutic diseases of the gums. The indestructibility of charcoal is such, that the beams of the theatre at Herculaneum, which were converted to charcoal by the lava which overflowed that city 1700 years ago, remain as entire as if they had been formed but yesterday; and about 40 years ago a quantity of oak stakes were found in the bed of the Thames, where Tacitus says that the Britons fixed a number of such stakes, to prevent the passage of Julius Cæsar with his army; they were charred to a considerable depth, retained their form completely, and were firm at the heart.

Charcoal, when combined with iron, forms plumbago, called carburut of iron, which, like charcoal, is indestructible by heat. When carbon is burnt in atmospheric air, it becomes converted into carbonic acid gas; it is the basis of all vegetables, it is one of the component parts of wax, oil, gums, and resins, and, from its affinity to oxygen, it has the property of decomposing *many* substances of which oxygen constitutes a material part (see page 392).

CHEMISTRY.

(Continued.)

Almighty Father!—God of might!
Canst Thou by laws so wise and just,
Rule every atom infinite—
Each meanest particle of dust,
And yet be far from man removed,
Deaf to the call of human woe?
Thy Word Thy love hath long since proved,
And loudly answers—No!

Thou art our Father, and will guide
Our faltering wandering steps to Thee.
Bend to our sorrows, and abide
With never-failing constancy,
Through all the tyrant griefs and pains
The stricken spirit, sad and lone
Through her terrestrial course sustains,
When peril cometh on.

Thou art "Our Father,"—not a sigh
Escapes the trembling breast in prayer,
But brings thy peace and solace nigh,
And sweetly whispers Thou art there.
To Thee the wounded soul makes wing,
Like some storm-wearied fainting dove,
And finds a solace still, to cling
Unto Thee clasped in love.

Thou art "Our Father,"—can we shed
In solitude a lonely tear,
But thy sweet balm is round us spread,
Although that drop the cheek may sear?
And shall we fear the stern array
Of human ill, when Thou canst bind
The broken heart, and be a stay
In anguish to the mind?

Thou art "Our Father,"—we can brave
The thousand stings of life and time,
And fearless meet the storms that rave
Round death's dark terrors, all sublime!
And why? Because we know each throe
Of pain but sets the spirit free
From all its weight of care and woe,
And gives it back to Thee.

CHAPTER XI.

Of Chemical Attraction, Repulsion, and Affinity.—Of the Properties of Metals.—Of Oxides.

Of Chemical Attraction, Repulsion, and Affinity. The attraction which subsists between the *particles* of bodies is termed chemical attraction: whenever the force of this attraction operates between particles of the *same species*, it is called the attraction of cohesion, but when between particles of different substances, it is called chemical affinity. The particles of every simple substance have not only an attraction among themselves, but also for such other substances with which they have an affinity, and when presented unite to them, and form a new compound. Chemical attraction only exists between particles of opposite and distinct substances.

Repulsion is another property inherent in the particles of matter, which gives them a constant tendency to recede from each other. The only kinds of repulsion which can be exhibited to the senses, are those of electricity and magnetism: it is the *insensible* repulsion with which Chemistry is concerned. In order that the attraction of composition may take place between two bodies, it is generally necessary either that one of the

substances should be in a state of fluidity, or that heat should be applied; so that caloric acts an important part, either sensibly or insensibly, in all cases of chemical affinity.

We have reason to believe that every new compound is produced by virtue of the attraction to which all matter is subject, and which is equally operative on the minutest atom, as on a planetary system: thus we see that the Almighty is as careful about the preservation of the minutest atom, as of the millions of worlds which surround us; and can we suppose that He should be so careful about the smallest particles of dust, and not about His rational creatures? It was indeed truly said by Cleanthes and reiterated by the Apostle "In Him we live, and move, and have our being."

Examples of Chemical Affinity. Take a little common magnesia, and pour by degrees diluted nitrous acid upon it, until the whole of the earth be dissolved: this is an instance of simple chemical affinity; but if a solution of potass be poured upon the former mixture, the potass, having a greater affinity for the acid, will take it from the magnesia, and the magnesia will again appear, and be precipitated to the bottom of the vessel.

Dissolve a few ounces of sulphate of iron in water, by adding it by degrees, till the liquor becomes turbid; dip a skein of cotton thread in it, and it will be found to take up the whole of the oxide of iron, and the liquor will be transparent: this effect is produced by the great affinity which cotton has for the oxides of iron.

Take a little tincture of galls, and a little of the solution of green copperas, both colourless liquids; pour these together, and the mixture becomes black, from the affinity which gallic acid has for the oxide of iron in the copperas: then pour a little weak aquafortis, and the liquor will become transparent; this arises from the

metal leaving the first acid to unite with the last, to which it has a greater affinity: but if a solution of potass be now added, the nitrous acid will quit the iron, and unite with the alkali; thus the iron, being once more disengaged, will again be caught by the gallic acid in the infusion, and once more produce a black colour.

Of the Properties of Metals. In the article Mineralogy we have made some remarks upon the principal metals; we now proceed to remark upon the changes they undergo by the absorption of oxygen, and other causes.

Metals are generally taken from the bowels of the earth, in a state of combination with other metals, with sulphur, oxygen, and acids, some few only are found pure. Every metal possesses some specific difference from the others, and in the ore are found under determinate forms, or geometrical figures of different characters; these peculiarities of the figures of the particles that compose them, are not destroyed when reduced by art to a metallic state. Thus when the surface of a melted metal begins to congeal, if the crust be broken, and the parts still in a fluid state be drawn off, the parts which had cooled will exhibit a regular metallic crystillization.

Metals are also rendered infinitely valuable by various other properties which they possess; by their combustibility, their solubility in fluids, their combinations with phosphorus, sulphur, and carbon; and by their union with each other, whereby compounds or alloys are formed, they are highly useful in common life.

Nature renders these metals subservient to *us, by furnishing* us with solvents (acids) for the

most refractory metals, by which they may be easily dissolved and purified, and thus rendered fit for a variety of purposes. By combining metals with oxygen, we can invest them with new properties, and are enabled to imitate the masterpieces of creation in the production of artificial salts, gems, and crystals, of every colour and variety. Thus a solution of gold made by nitromuriatic acid, or oxymuriatic acid, when concentrated by evaporation, yields beautiful yellow crystals, like the topaz. Gold is also used in solution for staining ivory and ornamental feathers, to which it gives a beautiful purple red, which cannot be effaced; while silver dissolved in nitric acid, forms a salt called nitrate of silver, which when melted and run into moulds, forms the lunar caustic of the apothecary; when dissolved in water, and left at rest, it crystallises in brilliant transparent plates of different forms, and though this solution be as pale as water, it will stain marbles and jasper, and dye the skin, hair, and all animal substances, of an indelible black; this salt is the most powerful antiseptic known; one ounce of it dissolved in 12,000 of water, will preserve it from putrefaction for ever, and may at any time be separated therefrom by adding a lump of common salt. Hyperoxygenized muriate of silver is used in making fulminating powder, which, by being mixed with half its weight of sulphur, and struck slightly, detonates with a loud noise. Platina in the state of oxide is *used in* enamel painting, as it is never liable to *tarnish*, Mercury is the basis of the pigment

called vermillion, and its uses in medicine are universal:—Keyser's pill, which is an acetate of mercury; turbith mineral, a sub-sulphate of mercury; red precipitate, an oxide by means of nitric acid; calomel, muriate of mercury; corrosive sublimate, an oxymuriate, &c. The oxides of copper are employed in enamel painting, and are used by the glass makers to stain glass of a beautiful green. Roman vitriol is a sulphate of copper, which is used to brown tea urns, &c. Blue verditer is a nitrate of copper, combined with hydrate of lime; mineral green is precipitated in a peculiar way from sulphate of copper, by means of caustic, potash, and oxide of arsenic. Iron produces green vitriol, so much used in dying, and various preparations of it are used by the calico printers. Sulphate of iron is used in the manufacture of ink and Prussian blue; it is the cause of redness in common bricks; it gives colour to the cornelian, the garnet, and other precious stones; and with different proportions of oxygen, it imparts other and different colours, gives blue to the lapis lazuli, and yellow to the topaz. Tin, in the state of a white oxide, is used to form an opaque glass, called enamel, and a combination of the white oxide with sulphur, by means of mercury, forms aurum musivum (mosaic gold.) A solution of tin with cochineal gives a most intense and beautiful scarlet. Lead is indispensible in the manufacture of glass. Nickel affords the manufacturers of porcelain a very delicate grass green, and glass may obtain from it a very beautiful hyacinthine colour.

Antimony is one of the most valuable of medicines; Bismuth affords the cosmetic called pearl white, which is an oxide of this metal; Arsenic is used to whiten copper, and its oxides are employed in the manufacture of glass as a purifier; orpiment and realger are both sulphurets of this metal. The pigment called *king's yellow* is also made from it, and the beautiful colour called Sheeles green is a preparation of it. Cobalt, in a state of oxyde, forms the most permanent blue colour we are acquainted with; muriate of cobalt, much diluted, forms the sympathetic ink; it is extremely valuable to the manufacturer, as it not only produces a beautiful colour, but endures the intense heat of their furnaces without any deterioration. The oxides of Manganese are used in bleaching, in purifying glass, and in glazing black earthenware; the rubelite and amethyst owe their colour to the red oxyde of manganese; the black oxyde is used in painting porcelain, to which it gives a beautiful purple colour; and it produces the largest quantity of oxygen gas, about 40 per cent. to the chemist, by the application of a red heat. Chromium gives a beautiful green colour, used for painting, and imparts a lively colour to a variety of other bodies; the emerald is coloured by an oxide of this metal.

In endowing the metals with such a variety of properties and principles, nature seems to have had in view all the necessities of man, in order that he might suit them to every possible purpose *his ingenuity* could invent, or his wants require, *proofs* that the organization of the world has

been effected by consummate wisdom and goodness, attributes belonging to Him only, who has thus supplied our wants and ministered to our comforts, and even to our luxuries.

Of Oxides. Any metal or combustible combined with less oxygen than is sufficient to render it *acid*, is called an *oxide*. The mineral, the animal and vegetable kingdom, all furnish matters which are converted into oxides by a union with oxygen. Metals, with some exceptions, generally become oxidized by the access of atmospheric air, by the decomposition of water, and by the decomposition of acids.[1] All metals are incapable of dissolving in acids until they are combined with oxygen. All the oxides with which we are acquainted may be thus classed: 1, those arising from the combustion of hydrogen, by which water, the oxide of hydrogen, is formed; 2, metallic oxides; 3, acidifiable oxides, or such as, by an addition of oxygen, pass from the state of oxides to that of acids; the oxides of phosphorus, sulphur, and nitrogen, with four of the metallic oxides, admit of this change; 4, various combinations of carbon and hydrogen in the animal and vegetable kingdoms; to this class belong common charcoal, oils, gums, resins, wax, sugar, yeast, soap, &c.

[1] The common red-lead of the shops, which is a true oxide of lead, is made by heating the lead in large shallow vessels, for the purpose of its being oxidized by the atmosphere, when the pellicle which rises is skimmed off, and ground into a powder. Iron, zinc, tin, and antimony become oxidized by their having the power of decomposing *water*; *rust* upon polished iron is occasioned by *the iron imbibing* the oxygen of the water when it decomposes.

CHEMISTRY.

(Continued.)

In earth, in air, in sea, or sky,
We see, oh, Lord! thy will is done:
And every atom still will cry
Obedience to the Mighty One:
Shall rock and gem, and bud and flower,
The workings of thy will sustain?
Shall nature thus confess thy power,
And man alone complain?

No, let him deem Thee still, in all
Thy dispensations wise and just.
When barbed woes or sorrows fall
Upon our weak impotent dust,
Oh! let us feel in all Thy care,
While still the sands of life shall run,
And feeling, breathe the constant prayer
To "Let thy will be done."

When those we love give up their breath,
And pass like shadows to their rest,
Then, as we close their eyes in death,
And to our lips the hand is prest,
When the last look and kiss is given,
Oh! let us hope that they have won
A crown of light and life in heaven,
And cry—Thy will be done.

The feverish lip, the burning brain,
The sinking heart, the fading bloom,
And many a throb or shriek of pain
May warn the body of its doom;
And though in these the spirit clings
To earth, and lingers with the sun,
Yet let it, ere to heaven it wings,
Sigh soft—Thy will be done.

The Lord of life, who taught us how;
Who taught us even thus to pray;
On Olivet, when bending low,
Wrapped in a vest of mortal clay,
Thrice knelt, and thrice aloud did cry,
His hour of peril then begun—
Even in his sweating agony,
"Father, Thy will be done."

CHAPTER XII.

Of the Earths, Acids, Alkalies, Salts, &c.

Although there seems to be an almost infinite variety of earthy substances scattered on the surface of the globe, yet when chemically examined, we find that all the earth and stones which we tread under our feet, and which compose the hardest rocks as well as the numerous specimens which adorn the cabinets of the curious, may be reduced into ten distinct kinds—they are

1, Silex; 2, Alumine; 3, Barytes; 4, Lime; 5, Magnesia; 6, Strontites; 7, Yttria; 8, Glucina; 9, Zirconia; 10, Jargonia. Barytes, magnesia, lime, and strontites are called alkaline earths. The five last are but little known.

The properties of the earths are insipidity, dryness, incombustibility; are insoluble in water, or nearly so, and are of a specific gravity never exceeding five times that of water.

Silex, or silicia, is found in almost all mineral substances, particularly in flint, sand, sandstone, agate, quartz, and is the principal ingredient in granite; it is the basis of glass and all vitreous substances, it is also the base of all the artificial gems, and is largely used in the more beautiful kinds of porcelain. Alumine is s

called from its being the base of alum; it is found in a state of crystallization in the sapphire, ruby, and amethyst; in the state of pure clay it is employed for making bricks, earthenware, crucibles, &c.; it is employed as a mordant by the dyer, and artificially combined with sulphuric acid, forms alum.

Barytes is of a greyish white colour, and is remarkable for its weight, strong alkaline qualities, such as destroying animal substances, turning blue vegetable colours green, and shewing a powerful attraction for acids.

Lime is never found in a pure state, but generally in combination with an acid, as in chalk, marble, lime-stone &c.; combined with water and carbon it forms the common lime-stone; chalk is a carbonate of lime, or lime combined with carbonic acid; lime is employed by the farmer as a manure to hasten putrefaction, also by tanners, bleachers, sugar bakers, soap boilers, and in medicine.

Magnesia is a soft white light earth, unalterable in the fire, and almost insoluble in water; combined with sulphuric acid it forms sulphate of magnesia, or Epsom salts. It is the most effectual antidote in case of poison by the mineral acids.

Strontian and Yttria have not yet been employed for any useful purposes.

OF THE ACIDS.

Most of the acids are substances which produce that sensation on the tongue called sour; *some however* have not this characteristic. *Acids change the* blue, green, and purple juices of vegetables *into* red, and combine with alkalies, earths,

or metallic oxides, so as to form those compounds called salts. Most of the acids owe their origin to the combination of certain substances with oxygen, which has been called the acidifying principle; they may be thus classed :[1]

1. *Mineral Acids.*

Sulphurous, Sulphuric, Nitrous, Nitric, Muriatic, Oxygenated muriatic, Carbonic, Fluoric, Boracic.

2. *Metallic Acids.*

Arsenious, Arsenic, Tungstic, Molybdic, Chromic, Columbic.

3. *Vegetable Acids.*

Acetous, Malic, Oxalic, Citric, Tartareous, Benzoic, Camphoric, Gallic, Succinic, Surberic.

4. *Animal Acids.*

Phosphorous, Phosphoric, Bombic, Sebacic, Laccic, Lactic, Saccho-lactic, Uric, Prussic.[2]

Sulphuric acid is obtained by burning sulphur and nitre in a close receiver over water; it then becomes, after being concentrated by boiling, what is vulgarly called oil of vitriol.

Nitric acid is what is sold in the shops under the name of aquafortis; it is obtained from nitrate of potash and sulphuric acid by means of heat, and will dissolve all metals except gold and platina.

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[1] If a lesser quantity of oxygen be combined, it is denoted by the termination *ous;* if a greater, by the termination *ic.* Thus sulphurous acid is the weaker, and sulphuric acid the stronger of the two.

[2] *We have* preferred classing the acids thus, *this classification being* the most simple and easy of comprehension.

Muriatic acid, *vulgo* spirits of salt, is a peculiar acid, obtained from sea salt by means of sulphuric acid. According to Sir H. Davy, muriatic acid is a compound of hydrogen and oxymuriatic acid.

Oxygenated muriatic acid, is muriatic acid with an excess of oxygen.

Carbonic acid is produced from the combustion of carbon: it exists in the gaseous state, and in combination with the different bases it constitutes carbonates.

Fluoric acid is obtained from Derbyshire spar, and is separated from it by sulphuric acid. It has great affinity for silex, and engraving may be performed with it on glass, as etching is on copper by the nitric acid.

Boracic acid is a concrete acid extracted from soda and borax with which it is combined, by sulphuric acid, and appears in the form of shining scales: it may be decomposed by burning in contact with it *in vacuo* potassium; the potassium attracts the oxygen from the acid, and leaves its basis in a separate state; by burning this in oxygen gas, its light is extremely brilliant, and the result is boracic acid.

Molybdic acid is a pale yellow powder, procured from the sulphuret of molybdenum, by distilling nitric acid off it repeatedly, till the sulphur and metal are both acidified.

Chromic acid is compounded of chromium and oxygen, and forms an orange coloured powder: it has a hot metallic taste, dissolves easily in *water*, and when mixed with different saline so*lutions*, it assumes a variety of beautiful colours.

Arsenic acid is composed of arsenic and oxygen. Tungstic acid is a tasteless yellow powder, composed of oxygen and tungsten. Acetous acid is principally obtained from saccharine liquors which have undergone the resinous fermentation; it is known in commerce by the name of vinegar. Oxalic acid is a peculiar acid, found in sorrel, in combination with potass, and its base is in all saccharine substances; it is much used by the calico printers, and is a deadly poison. Tartaric acid is found in the cream of tartar of commerce. Citric acid is found in the juice of lemons, &c. Malic acid is found in the juice of apples. Lactic acid is prepared from milk. Gallic acid is found in the galls of commerce. Benzoic acid is prepared from gum benzoin. Succinic acid is obtained from amber; Camphoric acid from camphor; suberic acid from cork; Laccic acid from white lac. Prussic acid is a peculiar acid composed of hydrogen, nitrogen, and carbon, and so strong a poison, as to destroy life at times upon merely coming in contact with the skin; it is supposed to act by deoxidizing the blood. Sebacic is produced from animal fat or tallow. The Uric acid is found in human urine, and is composed of carbon, nitrogen, hydrogen, and oxygen.

These acids are such powerful agents in a variety of chemical changes which take place in nature and in the arts, that it is of the utmost importance to acquire a knowledge of the mode in which they operate. There are two ways in which the acids produce changes in the substances with which they are brought into contact: in some cases they effect a union with

these substances, and become a part of the new compound, without having themselves undergone any decomposition; in others, they become partly decomposed by affording a part of their oxygen to the bodies on which they operate: the formation of saltpetre, or nitre, with the addition of nitric acid to potass, is an instance of the first of these cases, and the action of the same acid upon iron will exemplify the latter.

OF ALKALIES.

The word alkali is of an Arabian origin, and signifies the dregs of bitterness. The properties of alkalies are, metallic bases, an acrid taste, a pungent smell, and a caustic action upon animal substances; they are capable of converting a vegetable blue to a green colour. Alkalies are divided into two classes, the fixed and volatile. The fixed are divided into vegetable and mineral, the former being the product of vegetables burnt in the open air, and the latter have sometimes been found native in the earth. In the first class of alkalies we have Potass and Soda; in potass, about 86 parts of potassium to 14 parts of oxygen; in soda, 77 parts of sodium to 23 of oxygen: these are called the fixed alkalies. In the second class we have Ammonia, containing 6 parts of nitrogen and 1 of hydrogen or azote. Till lately the fixed alkalies were thought to be simple substances, chemists not having been able to decompose them, but by the splendid discoveries of Sir H. Davy, through the medium of galvanical experiments, it has been proved beyond all doubt that potass and soda are both metallic oxides.

Of Potass. Potass was called the vegetable alkali, because it was supposed to exist only in vegetables; it is however found in some minerals. The potass of commerce is chiefly procured by lixiviation from the ashes of burnt wood and other vegetable substances, which in all probability derive it from the earth; hence it may be proper to discard the word vegetable entirely, when speaking of this substance. The properties of potass are — 1, it combines readily with oil or fat, and forms soap; 2, melted with silicious earth or flint, it forms glass; 3, it is extremely useful in many of the earths, and combined with nitric acid forms saltpetre.

Of Soda. Soda has been known only of late years, and it so nearly resembles potass in its several properties, as scarcely to be distinguished from it; it is generally procured from the ashes of marine plants, by an operation similar to that by which potass is obtained from other vegetables. It is supposed that vegetables have the power during their vegetation of decomposing sea salt, and retaining the soda in their constitution, which is separated from it upon the combustion of the vegetable. Soda is one of the substances found in the bile of animals. Whenever this alkali occurs native, it is always in a *mild* state, and as it cannot combine with oils to form soap, unless it be caustic, this causticity is given it for these manufactures by artificial means: deviating from this general rule, nature has been careful to furnish the bile with soda in a state of *causticity, which* gives it the quality of *combining with* and soporifying the fat and oily sub-

stances taken into the stomach, and rendering them soluble in the other animal fluids,—another instance of Divine care and wisdom. The fixed alkalies have various uses in the arts and medicine; they are the bases of several salts, are employed much in the arts, are used in large quantities by the glass maker, the dyer, the soap maker, &c., and are of the greatest importance to the analytical chemist.

Of Ammonia. The chemical name of volatile alkali is *ammonia;* it is resinous and caustic, but does not corrode animal substances like potass or soda; its most simple state is that of gas, called ammonical gas; in this state it is lighter than common air in the proportion of 3 to 5.

Ammonia is a compound of nitrogen and hydrogen, of about 807 parts of the former, and 193 of the latter; it has great affinity for water, with which it readily combines, and forms liquid ammonia.

All animal and vegetable substances, when in a state of putrefaction, will furnish ammonia; it is however in England generally procured by a dry distillation of bones, horns, and other animal substances.

Ammonia may be decomposed by the electric spark; oxygen gas will also decompose it, with the assistance of heat, and then nitrous acid and water will be the result; if passed over red hot charcoal, it will combine with part of the charcoal, and form prussic acid. Decomposed in *contact* with mercury by means of galvanism, it *gives* a metallic substance of a very uncommon *nature:* this was one of the last of the surprising *discoveries* of Sir H. Davy.

When ammonical gas is poured into carbonic acid gas, the two gases become condensed, a crystallization of carbonate of ammonia in silky fibres, or fine powder, takes place upon the surface of the vessel. This is a beautiful experiment, but must be made over mercury and not over water, as water would absorb the ammonical gas.

Muriate of ammonia is made by combining ammonia with muriatic acid; it is known in commerce by the name of sal ammoniac.

Ammonia in its several states is highly useful in a variety of the arts, and largely in the making of snuff, also by dyers, braziers, &c.

The reflection that naturally arises from a consideration of this subject is, that the original organization of nature, whereby the recrementitious parts of animals and vegetables are made capable of producing useful and powerful substances, evinces that Infinite Power and Wisdom, united with consummate Beneficence, can effect the most important changes by the most unlikely agents, and can convert to valuable purposes, substances which appear to us totally useless and inert.

OF SALTS.

The word salt was originally confined to muriate of soda, our common salt; the term is now applied to all the compounds which the acids form with alkalies, earths, and metallic oxides. The number of species of salts Fourcroy reckons to be 134; the number of distinct salts are supposed to exceed 2,000. Chemists have agreed to denominate the salts from the acids they contain: thus all substances which are compounds of metallic oxides, earths, or alkalies, with the

sulphuric acids, are called *sulphates;* with the muriatic acids, *muriates;* with the nitric acid, *nitrates;* with the carbonic acid, *carbonates*, &c. but sometimes an adjective termination is given to the word, which expresses the base of the acid, as calcareous salts, instead of salt of lime, ammonical salts instead of salts of ammonia. In conformity with this plan the saline compound formerly called Glauber's salt, is now called sulphate of soda, for it is a combination of sulphuric acid and soda; what was called gypsum, or plaster of Paris, a compound of lime and sulphuric acid, is now called sulphate of lime, and what was called green copperas, is now called sulphate of iron, that substance being a compound not of copper, but of iron and sulphuric acid. Some salts are formed with acids not fully oxygenated, as the sulphurous and phosphorous acids; all salts therefore that are composed with acids, ending in *ous*, take an ending in *ite* instead of *ate*, as sulphite of lime, or phosphite of potass. When a salt is found to contain an excess of acid, the preposition *super* is generally prefixed to its name, but when it does not contain a sufficiency of acid to saturate the base, the preposition *sub* is added; thus we say, supertostrate of potass, and sub-borate of soda.

OF COMBUSTION.

Combustion is a process by which certain substances decompose oxygen gas, absorb its base, and suffer its caloric to escape in the state of *sensible* heat. Chemists class combustibles into *3 classes*—1, simple combustibles; 2, compound *combustibles*; and combustible oxides.

The simple combustibles are Hydrogen, Sulphur, Phosphorus, Carbon, and all the metals except gold, silver, platina, and mercury.

Compound combustibles are formed by the union of two or more of the simple combustibles. Hydrogen and carbon intimately united in the capillary tubes of vegetables, form bitumens, oils, resins, which are compound combustibles; common coal is also an instance of this combination.[1]

The supporters of combustion are seven, viz. oxygen gas, atmospheric air, nitrous oxide, nitric oxide, nitric acid, oxymuriatic, and hyperoxymuriatic acid; to these may be added water. These, although not of themselves combustible, are indispensible to the process; when combustion takes place, the combustible and the supporter of combustion divide themselves into two portions, which combine in pairs, the one forming the product, the other the fire, which escapes.

The heat produced from combustion arises from the decomposition of the oxygen gas of the atmosphere; for, as the oxygen combines with the combustible body, it disengages the caloric which it held when in the state of atmospheric air, to it which effects a real analysis. The light and flame that appear during the process of combustion, is proved to proceed from the combustible body. Experimental chemists have exposed a mixture of sulphur and zinc to a high temperature, without any substance being present from which they could derive oxygen; at the instant when the sulphur

[1] *We are acquainted with fourteen incombustible bodies, viz. nitrogen, chlorine, the three alkalies, and the nine earths.*

and zinc formed a *sulphuret*, there was a vivid emission of *light*, and when the materials were examined, it was found that no oxidement had taken place.[1] That a great part of the light comes from the combustible is evident, from the colour of the light generally varying according to the nature of the combustible: carbonic acid burns with a blue flame, carburrutted hydrogen with a white, charcoal with a red, and sulphur with a blue or violet. If quick lime be slacked in the dark, the liberation of light will be very evident.

When a body is fully burnt, it is saturated with oxygen so far as combustion can saturate it, and cannot be rendered combustible again, but by depriving it of some of the oxygen which it absorbed in its former combustion. The chemical name given to burnt bodies is, that they are oxygenized or oxidized, that is, changed into acids or oxides.[2]

When bodies are burnt, none of their principles are destroyed: they had previously formed together one kind of compound, and they now separate from each other at the high temperature to which they are exposed, in order to form others with the vital air in contact with them; such of the principles as cannot unite with the vital air, that is, the earth, some saline, and some metallic

[1] Philos. Mag. vol. xv. p. 207.

[2] Water is a product of combustion, and its base is hydrogen, the most combustible substance we are acquainted with. To restore the combustibility of the hydrogen we have only to abstract its oxygen, which may be easily done by mixing iron filings and sulphuric acid with the water, by which means the metal becomes oxidized, and the hydrogen gas is evolved as combustible as ever.

particles, compose the cinder. The new compounds formed are carbonic acid, or fixed air, and water; the proportion of these varies according to the proportion of the carbonic particles, and of the hydrogen that had been contained in the inflammable body.[1] Thus we have reason to think that every particle of matter is indestructible, and that the process of combustion merely decomposes the body, and sets its several component parts at liberty to separate from each other, to form other new and varied combinations, and nothing less than consummate wisdom could have devised so beautiful a system. It is said in Scripture that the Creator *weighed* the dust and *measured* the water, when He made the world: the first quantity is here still, and though man may gather and scatter, move, mix, and unmix, yet he can destroy nothing: the putrefaction of one thing is a preparation for the being and the bloom and beauty of another:[2] something gathers up *all* fragments, and nothing is lost. Thus we are led to refer every thing to design, to never-ending superintending Providence, and to unerring Intelligence, combined with Infinite Goodness.

[1] Berthollet.

[2] In the decomposition of a vegetable, it is resolved into its simple and primitive ingredients, hydrogen, carbon, oxygen, and azote; but in this process a variety of new combinations are successively established and destroyed. A violent intestine motion pervades vegetables during their decomposition, produced by the disunion of one order of particles, and the combination of another—this is called fermentation: there are several of these fermentations, but the last, or putrid fermentation, is the final *operation* of nature towards reducing organized *bodies to their* simplest combination.

ELECTRICITY.

MAN, thou canst draw the lightning from the clouds,
And yet must die—canst soar from world to world,
Counting the glowing stars, and numbering
The proud array of bright and glittering orbs,
And yet must turn to dust——Dost rule alone,
Sole monarch of this lovely earth, and all
Its creatures do thee homage, yet the worm
Shall triumph over thee——Shudder thou wretch,
Whose eyes are only on this fleeting shade
Called life—and tremble, thou base recreant slave,
Whose hope has been laid prostrate at the foot
Of this vain world—Lo! dust—the grave—the worm
Are ready all to seize thee—Death will come
Perhaps to smite thee from some pinnacle
Of earthly glory, and to dash thee down,
When thou wouldst eagle-like exalt thyself
And fix thy nest among the stars.——Awake,
Awake, thou grovelling earth worm—Lo! the sun
Is in the heavens, his vivifying smile
Would pierce thee like a sword, and slay this clod
Of earth, that the enraptured spirit might
Drink deep of *immortality* from all
The boundless stores of nature—Rapturous thoughts,
Ineffable sensations, high desires,
Say, are they not engendered day by day,
And hour by hour, from all that's bright and fair
And beautiful around us.—Oh! the gaze
Of melancholy twilight, through her tears
Of purest dew, dropping like pearls, distilled
From the soft sunset ray, and the dear glance,
Love-like and tender as the look of love
Of Cynthia, taking out the bosom's stains
With her soft beams of holy light; what things
They speak of to the chosen soul—and thou
Eternal and all gorgeous canopy,
Looking upon us in the gloomy time

Of solemn midnight, with ten thousand eyes
Of clear unutterable brightness,—tongues
Eternal tongues of never-dying fire
Are in your glory, that will speak aloud
To man of immortality, and give
Him fond assurance he shall never die.

Man is immortal!—Death, thy iron crown
Totters upon thy brow, and Victory's palm
Falls from thy palsied grasp—Though Sin did bring
Thee forth into this breathing world, and seemed
To set thee up against heaven's King, and gave
Thee power to wrench from out their orbits, all
The planets one by one, to turn the light
Of the innumerable suns His pride
To darkness, and the warm and glowing torch
Of his enduring love into a cinder,
Black as thy shrivelled arm: Though thou dost hurl
From age to age, and century to century,
The dust of empires in his face, and fain
Would grieve his heart by making ceaseless havoc
Upon the fairest things, His workmanship.
Though thou dost chill the hearts of mortal men
From the first hour they breathe, with quaking fears
And icy shudderings,—wouldst pall the glory
Of bright creation with a cloud, and darken
Existence, his great boon, favour, and gift,
With thy forthcoming shadow, and dost make
The universe, *His* temple, also *thine:*
And while he *maketh*, thou wouldst still *destroy*,
And by destroying wouldst become more great
In desolation, than He in the glory
Of his unnumbered worlds!—yet man defies
Thy shaft, for One from heaven hath been,
Mortality in immortality,
Enshrined to foil thee,—and thou hadst the power
To slay, yet couldst not slay—to kill, yet see
The dead alive again; to be the end,
Yet the beginning; a destroyer, yet
A saviour; and if thou shouldst even now
Lay this high-favoured and all-beauteous world

In one eternal ruin, and destroy
The very germs and essences of things
Material, and pluck from out his sphere
The gorgeous orb of day, and smite the host
Of planets and their myriad systems back
Into old chaos, *Spirit* would survive,
Perfected solely by that very act
To smile at thy vain impotence, and throw
Defiance in thy teeth, and brave thee still!

Man is immortal!—free, enfranchised, bought
By Love Divine, for bright inheritance
And never ending bliss—Oh! great indeed
The price was set, and dear, oh! very dear
The Sacrifice; but thou didst pay the whole,
Yea, drop by drop, in blood!—Saviour of men!
We worship Thee,—God of our hope! we bow
Before Thee, and would laud in endless praise,
Through time and through eternity, thy Name.

Man is immortal!—Let it be the key,
The pitch note, burden, chorus, symphony,
To every holy song that man may breathe,
Like incense towards heaven—Join in the theme,
Ye happy spirits round the throne of GOD,
Join in the glorious hymn, and softly touch
Your golden harps to the all-joyful strain;
Ye towering archangels, who are the heralds
And constant harbingers of God in heaven,
Proclaim it there, as a sweet new-born joy
For angels!—Let the joyful hymn resound
The hymn of man's high immortality
Through all the elements—earth, water, air,
Space vast and limitless, and the quick soul
Of all-pervading fire, catch up the glee,
And bear it through the universe on wings
Of lightning; and ye joyous morning stars,
That sang together when Omnipotence
Called light and beauty from dark chaos, as
This glorious world rolled forth in pristine bloom,
A habitation for mean man—do ye
Keep up the sound through all eternity,

Undying music for the radiant spheres,
The high immortal song of triumph, and
Of victory eternal——let it come down
On earth like the full beam of the bright sun,
That brings the blossom from the bud, and gives
The honey to the flower; touching the heart
As Memnon's statue was, to ceaseless sounds
Of harmony; let stricken breasts receive
It like the heavenly dew; let mortals breathe
It day by day, as their own vital air;
Let dying lips respire it—dying ears
Embrace the melody, while all the powers
Are fainting in the extacy of death,
And the poor liberated spirit flies
Towards her God and Saviour's outspread arms.

CHAPTER XIII.

First Electrical Machine.—Conductors and Non-conductors.—Electric Shocks. — Leyden Phials.— Franklin. — Electricity drawn from the Clouds.—Animal Electricity.

Electron, the Greek word for amber, has given the name to this science, that substance being observed by the ancients, about 600 years before Christ, to have the property of attracting straws, and other light bodies.

Electricity was very slightly known to the ancients, but when, after a long age of darkness, science began to be cultivated, Otto Guericke, of Magdeburgh, fixed a large globe of sulphur in a wooden frame, and by whirling it about rapidly, he made several discoveries: this was the first electrical machine. It was soon found that in certain cases electricity produced repulsion, as well as attraction; that certain bodies were capable of producing electricity, and others were not; and that bodies incapable of producing electricity were the best conductors of it. When

the science was farther cultivated, it was found that electricity might be produced in a great amount, and accumulated in jars, so that by then exploding it, effects similar to those of natural lightning resulted.

It appears that the electric fluid is equally distributed through all bodies; the certain portion which every body is supposed to contain, is called its natural share. If a body be possessed of more than its natural quantity, it is said to be positively electrified, and when it contains less than its natural share, it is said to be negatively electrified.

Bodies through which the electric fluid passes freely are called conductors, or non-electrics; those bodies which oppose the passage of electricity are called non-conductors, or electrics. The most remarkable of the electrics or non-conductors are as follows:— glass, and all vitrefactions, precious stones, resins, amber, sulphur, baked wood, wax, silk, cotton, wood, hair, feathers, paper, white sugar, air, oils, calces of metals, and all dry vegetable substances. The principal bodies termed non-electrics, or conductors, which convey electricity from one body to another, are—gold, silver, copper, brass, iron, tin, quicksilver, lead, the semi-metals, ores, charcoal, all fluids except air and oils, most saline substances and stony substances, and also all other bodies which contain more or less of the above.

Electricity is excited in the greatest quantity *by the* friction of conductors and non-conductors *against* each other.

Exp. Get a piece of fur of any sort, with which cover the thumb and forefinger; then take a strong riband of black silk, and having warmed them at the fire, draw the riband briskly between the finger and the thumb covered with fur, and electrical sparks will be excited: if a person hold his knuckles near the riband while this is doing, the sparks will be very sensibly felt.

To excite electricity in a more powerful degree, machines have been invented for rubbing together electrics and non-electrics, which are called electrical machines. An electrical machine is either a glass cylinder or wheel, which is contrived to rub in its rotatory motion against a cushion, and having a collecter to take off the electric matter excited by the friction unto a brass conductor, and from thence to transmit it to other bodies. If while such a machine is working, the hand touch the end of the conductor, a smart shock is felt, and if the place be darkened a luminous spark will be perceived. If any number of persons join hands and form a circle, they will all receive the electric shock at the same moment, which may be made more or less violent according to the velocity with which the machine is made to revolve: this is what is called the electric shock. The spark that is seen to attend the transmission of this shock has not only the appearance of fire, but is actually capable of setting fire to various substances that are easily inflamed. The motion of the electric fluid in thus passing from a positive to a negative body is so rapid, that it appears to be instantaneous: were 1,000 men to join hands, the shock would be felt by all of them at the same moment. When

any part of one side of a piece of glass is presented to a body electrified positively or negatively, that side becomes possessed of the *contrary* electricity to the side of the body it is presented to, and the other side of the glass is possessed of the *same* kind of electricity as the other body; this electricity communicated to the glass does not spread, but is confined to the part where it is communicated on account of the non-conducting quality of the glass To accelerate this communication, and to enable it to be applied to the whole surface, the glass is covered with tinfoil, which is called *coating* the glass: if a conducting communication be made between both of the sides of a glass so coated and charged with electricity, a *discharge* takes place. A vessel of this kind is called a Leyden phial, from the place where this property was first discovered. A small Leyden phial may easily be made: get a 6 or 8-ounce phial, and having dissolved some gum arabic, pour it into the phial, and make the gum cover all parts of the phial beyond *two inches from the mouth*; then put in brass or iron filings, and the gum will make them adhere to the bottle; then rub a piece of tin foil with gum, and wrap it round the bottle on the outside, but not nearer the mouth than two inches, lastly run a piece of wire through a cork sufficiently long to reach the bottom of the phial. When it is intended to charge this phial, it ought to be held sufficiently near the apparatus producing electricity, so that the wire may attract *the sparks*. By a phial thus charged a variety

of experiments may be made; when many of them are connected together, they obtain the name of an electrical battery. By means of a good electrical machine and large Leyden phials thus united, a great quantity of electrical fluid may be concentrated, and many striking phenomena may be exhibited: metallic wires may be melted down, spirits of wine may be set on fire, the strongest animals may be killed, the effects produced by lightning may be imitated.

Dr. Franklin proved by a variety of experiments, that the lightning of electricity, and the lightning that flashes from the clouds in a thunder storm, are exactly of the same kind, and to demonstrate this in the clearest manner possible, astonishing as it may appear, he contrived actually to bring lightning from the heavens by means of an electrical kite, which he raised when a storm of thunder was perceived to be coming on. This kite had a pointed wire fixed upon it, by which it drew the lightning from the clouds; the lightning descended from this wire along the hempen string that held the kite, and was received by a key tied to the end of it From the key was a silken string, which he held in his hand, and thereby the electrical matter could not come farther than the key, silk being a non-conductor. The key soon gave out sparks like an electrical machine, and he charged several jars, and performed several experiments, in precisely the same manner as if the jars had been charged by means of an electrical machine. Dr. Franklin in these experiments found that the

string would conduct electricity even when nearly dry, but that when it was wet it would conduct it quite freely, so that it would stream out plentifully from the key at the approach of a person's finger. The same experiments have been since performed times innumerable; where there is lightning it is an experiment that requires the greatest caution, as many have been hurt in performing it, and a Professor, the Abbe Rickman, at St. Petersburgh, was killed.

The discovery of the identity of lightning with electricity, suggested the means of securing buildings against the dreadful effects of lightning in a thunder storm, and this has been effected by fixing a pointed iron rod something higher than the top of the building to be protected, connected with a wire running into the earth. Iron being a powerful conductor, the lightning seizes upon the rod in preference to any other part of the building, and descends along it to the earth, where it is dissipated without doing harm.

Iron is such an excellent conductor, that by means of wire, electricity has been carried all the way across the Thames, and has set fire to spirits of wine on the opposite bank.

The force of electrical attraction may be observed in clouds rushing together previous to a thunder storm. The phenomenon of rain has been supposed to be owing to electricity; the thin particles of vapour which float in the atmosphere, by the attraction of electricity are collected together into globules, and by their gravity *fall to* the ground; in proof of this, we may

observe the heavy showers of rain which fall in summer after a thunder storm. Drops uniting in the upper and colder regions of the atmosphere, becoming frozen, fall in the form of hail. The regularity of the shape of the flakes of snow, proves their formation by some uniform cause.

Animal Electricity. Some animals possess the wonderful property of being able at pleasure to give a shock analogous to artificial electricity; they are the torpedo, the gymnotus electricus, or electric eel, and the silurus electricus. The torpedo is a flat fish, about 20 inches long, common in the seas of Europe; the electric organs it possesses are two in number, placed on each side of the gills. If the torpedo be touched with the hand, it generally communicates a slight shock; if touched with both hands at the same time, one being applied to its upper, and the other to its under surface, a shock in this case will be received which is similar to that occasioned by the Leyden phial. This shock appears to depend upon the will of the animal, each effect being accompanied by a depression of the eyes, and motion of the organs.

The electrical eel is about six feet long, some of them are said to be so large, as to strike a man dead with their electric shock. The mode by which this wonderful phenomenon is produced remains still a subject for scientific investigation. After the animal has discharged its electrical matter, the next shock is weaker, and when the animal is exhausted, it has lost all the power of producing any effect for some time.

The silurus electricus is found in Africa, but we have a very imperfect account of its properties; its length generally is about 20 inches. All these animals seem to use the electrical property as a means of defence,[1] proofs that the Father of all can endow the meanest of his creatures with properties the most various, infinite, and wonderful, for their common preservation. From one end to the other of the vast chain of creation, we see the same wisdom of design, the same providential care, and the same harmony of purpose. Let us not forget that man is at the head of this harmonious and all-perfect contingency and gradation of matter,—and the next step is Spirit—DEITY. Yes, though but an atom amidst immensity, yet holding a middle rank between heaven and earth, and endowed with an immortal soul, man stands close at the boundaries of the spirit land, with God's Spirit irradiating his spirit, filling it with high conceptions, and clothing it with a garment of eternal day. Beyond this little sphere he is enabled to soar on the wings of redeeming love, to seek His presence, and amid His glorious and all-infinite creation, admire—obey—adore!

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[1] Animal electricity is now usually referred to Galvanism.

GALVANISM.

Father! we have beheld thy glory here
But dimly—yet what beauty and what love
Have beamed from every atom of thy works,
To shew that thou art Wise, and Great, and Good,
And all-providing, and All-infinite.——
Bear with us in our weakness, if we fail
To feel the whole of thy perfections,—lift
Our hearts up in the overpowering flood
Of light encompassing thy Majesty,
Too much for this poor clay, when unsustained
By thy fond arm.——We followed Thee in joy
And admiration through fair Nature's vast
And boundless chain of things harmonious,
Beginning and proceeding, ending all
In Thee——saw countless systems poised
Mysterious by thy power, and suns and worlds
Make Thee their common centre; while the whole
Of this stupendous Universe proclaimed
Thee sole Creator and Preserver—God,
Omniscient and Omnipotent!——Then hear—
Oh! hear our prayer, Thou Mighty One—and smile
Upon this darkened universe within
Upon this rude chaotic breast, and call
As Thou didst on creation's morn, it up
To light and life and harmony,—thick clouds,
Black stagnant mists of rank iniquity,
Clog it on every side, and press it down
Towards eternal night, yet Thou canst lift
It up to perfect day——confusion reigns
Through the mind's inward world—Strife, malice, war,
Rage there in fierce defiance of thy power—
Send down thy Spirit, Lord, to soothe and quell,
Touch, calm, and heal.——Temptations range around
Us all in syren forms, with syren songs,
And lusts stand beckoning: lend, oh! lend thine aid
Against our common enemy, defend
Us still from our own ways—and oh! be near—

Be ever near the stricken heart, and as
Thou send'st the morning's pure and kindly dew
To the refreshing of the withered herb,
And makest the blighted trunk to spring again
In fairest blossoming,—send thy Spirit down
To the scathed bosom, struck into the dust
By thine own lightnings, let it bud again,
And blossom still more gloriously in Thee;
Restore it in the sunshine of thy smiles
To such perfection that it may bring forth
Fruits that will never perish, but abound
In rich profusion, till the harvest comes
When thou shalt look upon thy vineyard fair,
And rightly claim the produce of thine own!

CHAPTER XIV.

Discovery by Sulzer.—Galvani.—Mode of excitation.—Galvanic Pile.—Trough Battery.—Galvanical effects on Animals.—Conclusion.

GALVANISM is so intimately connected with electricity, that it may be considered a branch of the science. The first notice we find of this peculiar form of electric agency occurs in a metaphysical work published in 1767, by a German writer named Sulzer, who observed that by applying two metals, one above, and the other under the tongue, and then bringing them in contact, a peculiar taste was perceived. Sulzer did not trouble himself to ascertain the true cause of this phenomenon, which he hastily attributed to a vibratory motion excited by the contact of the metals, and communicated to the nerves of the tongue; but about the year 1791, Galvani, Professor of Anatomy at Bologna, made some important discoveries on this subject. He found, *that independent* of the usual modes of exciting *electricity* upon animal substances, that similar

effects might be produced by the developement of electricity at the surface of contact of different metals.[1]

The process usually adopted for producing galvanic electricity is to interpose between two plates of different kinds of metal a fluid capable of exerting some chemical action on one of the plates, while it has no action, or at least a different one, on the other plate, and then to establish a communication between the plates at some other part, either by their direct contact with one another, or by the intervention of conducting substances; thus is constituted what is called the galvanic circle. When these plates and intervening substances are multiplied, galvanism is more forcibly exhibited, increasing in proportion with an increased number of plates. This multiplication of the production of galvanism forms what is called the compound galvanic circle, and to this class belongs the galvanic pile, discovered by Volta, and called from him

[1] The action of this kind of electricity on a dead frog, as well as on other animals, occasions a tremulous motion of the muscles, and generally an extension of the limbs. If the legs of a frog recently dead be skinned, and a small part of the spine be attached to them, but separated from the rest of the body, and a part of the nerve proceeding from this limb be wrapped up in a bit of tin foil, or laid upon zinc, the motion of the limb will be very vigorous; the two metals may be placed, not in contact with the preparation, but in any other part of the circuit, which may be completed by means of other conductors, as water, &c.

the voltaic pile.[1] This is composed of alterna
layers of copper, zinc, and card wetted in s
water; these layers are made to succeed ea
other in regular order, to the amount of 50
100 pairs of plates, and if it is wished still
increase their power, any number of such pil
may be connected together so as to form a galvan
battery, by taking care that the order of successio
in the plates in the circuit be preserved inviolat

Various modes have been adopted of i
creasing the galvanic action, and what a
called trough batteries have been invented.

[1] A galvanic pile is easily constructed: get a sma
quantity of zinc, and melt it in a ladle, and make a fe
moulds in clay from a penny piece, in these cast a nun
ber of plates, say 20 or 30; then get as many penn
pieces, and as many pieces of card cut in the same shap
about the 16th. of an inch smaller than the penny piece
dip these in salt and water, squeeze out the supe
abundant water, and build up the pile, first zinc, the
wet card, then copper. and so on until the whole
finished; the sides of the pile to prevent its upsettin
may be made of 3 long varnished sticks inserted into
circular base. Having wetted both hands, touch th
lower part of the pile with a piece of copper wire, an
the upper part with another piece, and smart shoc
will be felt, increasing with the chemical action of th
plates upon each other. The same experiment may b
varied in every possible way, by bringing the wires int
contact with different parts of the body; a rabbit recentl
killed, by application of these wires to the nerves an
muscles, will exert its limbs, and leap as if alive. If
wire be brought from one end of a powerful galvan
pile, and inserted through a cork into a glass tube fille
with water, and if another wire be brought from th
other end of the pile, and inserted through a cork in th
other end of the tube, a decomposition of the water in
oxygen and hydrogen gas will take place.

trough battery is a long trough made of non-conducting materials and divided into compartments; into this a fluid is poured, and plates of zinc and copper, united into pairs, a pair of each falling into every compartment of the trough. A number of these troughs may be united together by connecting together the terminal plates of the adjoining troughs by slips of copper, taking care to preserve the order of the series. The voltaic battery belonging to the Royal Institution, is constructed upon this plan and consists of 200 separate parts, each composed of ten double plates, and each plate containing 32 square inches, the whole number of double pieces being 2000, and the whole surface 128,000 square inches.

By galvanic batteries of this and similar construction the most surprising effects have been produced; electric fire of extraordinary intensity has been evolved by wires proceeding from the different poles of the battery when brought into contact, or even when at a short distance from each other. In the electric flame thus produced, the most refractory substances, as quartz, the sapphire, fragments of diamonds, and points of charcoal and plumbago, have been fused, and many substances, formerly supposed simple, have been decomposed into their constituent parts: potass has been found to consist of oxygen and a metallic basis, to which the name of potassium has been given; the other fixed alkali, soda; the alkaline earths, lime, barytes, strontian, and magnesia, have also been found to consist of oxygen and a metallic basis; while the physiological effects of galvanism hav

been more striking, when large animals have been made the subject of experiment. Thus if two wires connected with the poles of a battery of a hundred plates, be inserted into the ears of an ox or sheep, when the head is removed from the body of an animal recently killed, very strong actions will be excited in the muscles of the face every time the circuit is completed. The convulsions are so general, as often to impress the spectator with a belief that the animal has been restored to the power of sensation, and that he is enduring the most intense sufferings; the eyes are seen to open and shut spontaneously, they roll in their sockets, as if again endowed with vision, the pupils being at the same time widely dilated, the nostrils vibrate as in the act of smelling, and the masticatory movements of the jaws are imitated. The struggles of the limbs of a horse galvanised soon after it has been killed, are so powerful as to require the strength of several persons to restrain them. The effects of some experiments performed upon the human subject, a malefactor executed at Newgate, were so awful as actually to frighten one or more of the students who witnessed them; the body raised itself suddenly up, lifted its arm, and with the eyes staring, and the muscles of the face depicting the most intense agony, struggled apparently in convulsions.

Various attempts have been made to account for the phenomena of galvanism, by the application of the laws which are known to govern *electricity*, but these have been attended with *very little* success, and the theory of this *science* remains involved in considerable un-

certainty and obscurity; all that can be said to be fully established is, that the primary agent in the evolution of electricity is the force of chemical attraction.

CONCLUSION.

The task we had undertaken is now brought to a conclusion. We entered upon our subject by taking a general survey of the heavens, the resplendent beauties of which first captivated our attention, and gave birth to conceptions laudatory of the Divine Wisdom; we proceeded from apparent confusion to real order and harmony, from the most surprising effects to the simple but yet efficient cause by which they are produced. From the contemplation of the heavens we then turned to the earth, and proceeding through the mineral, vegetable, and animal kingdoms, became captivated with the wisdom and providential design displayed by the Creator, in the minutest as well as the most stupendous portions of his works, for we found that he had in degree stamped upon them all, some of those glorious perfections which essentially belong to Himself. Nor did the consideration of the laws which govern material bodies less administer to our instruction and delight; for in them we found the same infinite power, incomprehensible wisdom, and unbounded goodness, universally displayed. "Nature (says the eloquent Buffon) is the external throne of *Divine Majesty*, and man when he studies her, rises by degrees to the internal throne of Omnipotence;" and that he may *do so, God* has endowed him above all his other *creatures*, with the faculty of acquiring con

ceptions so far beyond the apparent limits of h
understanding. Powerfully impressed by sen
ments such as these, we sink in grateful adoratio
at the foot of that Eternal Being who presid
over the universe, and raising our eyes to th
starry heavens, to this glorious external man
festation of Infinite Power, Wisdom, and Goo
ness, let us join to the glory of the Godhead in a
universal

HYMN OF PRAISE.

I.

God, Jehovah, Lord,
Glory to Thee!
Creator, King, Redeemer, Incarnate Word,
Glory of all Glory—Light of all Light,
Essence Eternal, unchangeable, and bright—
Glory eternal, Glory unto Thee!
Spirit, pervading nature with thy ray,
Spirit, that fills the darksome heart with day,
Fountain of Truth Divine, failing us never;
Sun of our righteousness, beaming for ever—
Glory Eternal, Glory unto Thee!
Rock of salvation, Day-spring of holiness,
Deign, oh! deign to bless
Us, as with humbled hearts and bending knee,
And voice exalted, we unceasingly
Cry, Glory eternal Glory unto Thee!

II.

Countless myriads stand
Before thy Throne;
Millions of spirits form a glorious band,
And round thy dazzling footstool proudly shine
To acknowledge Thee in strains of melody divine,
The *First*, the *Last*, the Everlasting On
The high Archangel, with his trump of fire
Kindle the heavenly host and saintly choir,
*With Ever*lasting Love's imperishable flame,
To laud with sacred melody thy Name
Through all Eternity.

The cherubim are marshalled in thy gaze,
And ceaseless praise,
With the pure seraphim in burning throngs,
And loud hosannas, and unending songs,
Shout forth eternal Glory unto Thee.

III.

Spirits from this sphere
Of every clime,
High priests whose offerings shew salvation near,
Pure saints that walked with Thee in faith below,
And prophets, whose inspired words were bid to glow
Through every change of time;
Soft beings, whose meek breasts in this fierce world
were riven,
Dear martyrs, that arose from earthly flames to heaven,
Lov'd spirits of the Holy, softly drawn away
From this gross husk and prison of dull clay,
Unite in songs sublime,
Even with the angels ranked in proudest place
Before thy dazzling face,
Unite with all the heavenly hosts in sacred glee,
Compassed by Truth, and Love, and Joy, and Harmony,
Giving eternal glory unto Thee.

IV.

Sons of this drear earth,
Sleep, sleep no more,
But 'mid the raptures of a second birth,
Rise in the beauty of all holiness, above
This sphere of darkness, on the wings of love,
And freed from sorrow, soar
Towards Jehovah, throned in the excess
Of light, and love, and perfect righteousness,
Mount upwards to Him: oh! in meekness rise,
And praise Him in his temple of the skies
From the heart's inmost core:
Nor let the swelling organ peal refrain
To join the solemn strain,
When heart and spirit, soul and sense shall blend
With his eternal essence, and would bend
To worship and adore.

V.

Holy nature, come—
—and sweetly tell
His praise and wonders, for thou art not dumb;
Shout ocean from thy depths, shout, shout aloud!
And ye sublimer tempests, robed in cloud,
The diapasôn swell;
Blend in the glorious anthem, beast and bird,
And let your shrillest octaves still be heard,
Uprising with the incense of the vale,
Or borne in sweetest sounds upon the gale,
Till time and earth shall sever:
Whirlwind and storm, high doers of his will,
Join in the chorus still;
Close the great Hymn, ye thunders; catch the so
Ye everlasting hills, and bear it round
The barren desert and the shrubless plain,
And multiply its echoes to the main,
For ever, and for ever!

VI.

Praise Him, praise Him all
In earth or heaven,
And humbled in his presence, prostrate fall:
Praise Him—Redemption now is on the wing
To take from life its gloom, to take from death its
Praise his glorious Name:
Praise Him—the human breast can drink his vital
Praise Him—eternal hope doth bloom in mortal cla
Praise Him—ten thousand joys are centred in his W
Praise Him—his Spirit now is shed abroad,
A heart reviving flame:
Praise Him—the prisoned soul shall yet survive to s
Her immortality.
Sing Hallelujah! Hallelujah from afar,
Sing praise from world to world—sing praise from
to star,
Praise to Lord—Hallelujah!

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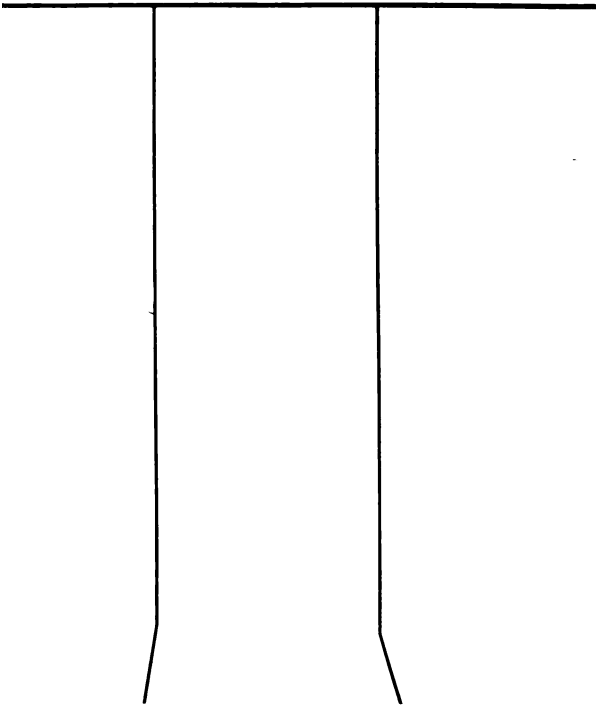
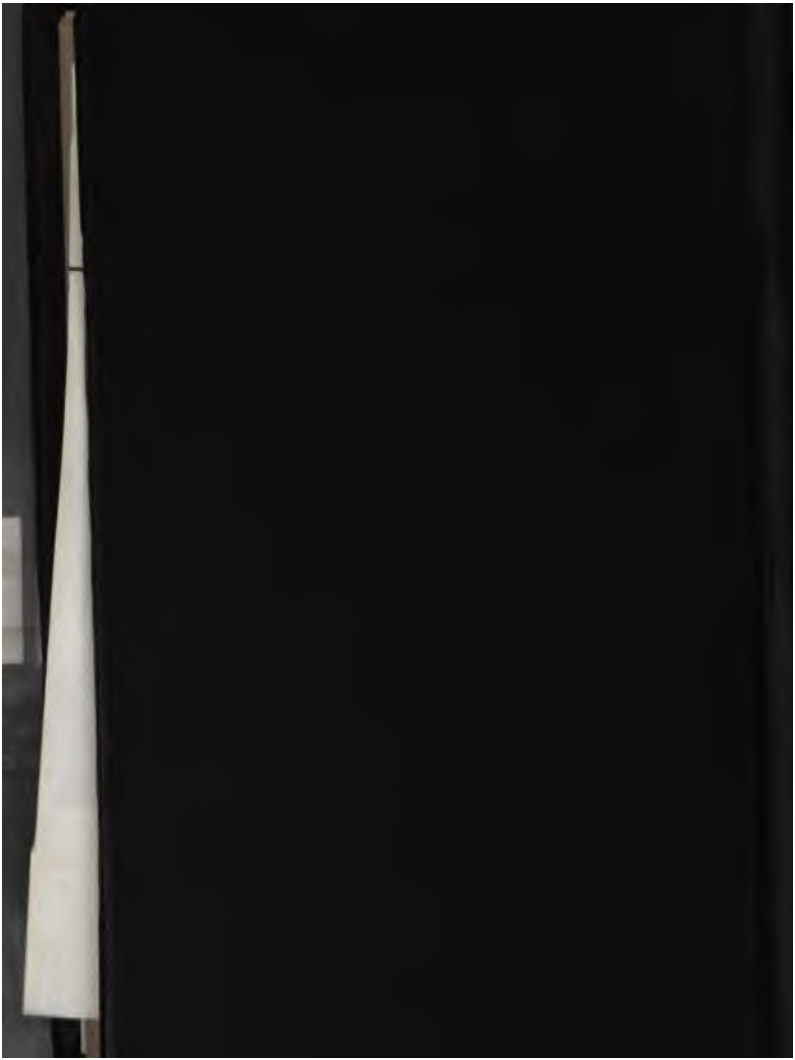
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